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SCIENCE AND LABOUR

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SCIENCE & LABOUR

Being the Principal Addresses at the Conference on Science and Labour held in London on 30th and 31st May 1924

EDITED BY

THOMAS LLOYD HUMBERSTONE

WITH A PREFACE BY

RIGHT HON. LORD ASKWITH, K.C.B., K.C.

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PREFACE

The British Science Guild initiated the Conference on Science and Labour held at the British Empire Exhibition in May, 1924, and carried out the arrangements for the Conference in co-operation with the National Joint Council of the Trades Union Congress and the Labour Party, by means of a committee composed of representatives of both bodies. This book is designed to record the principal lectures and speeches given at the Conference.

The object of the Conference was to consider the lines upon which science could be directed and applied more widely and effectively to increase human health, happiness, and efficiency, to reduce human toil, and to develop human personality.

Huxley bluntly remarked that " Science is nothing but trained and organized commonsense," while Bacon (in Latin) said " Science is but an image of the truth." If that be so, there is a wise proverb, " Truth is the daughter of Time," and progress in the object of the Conference will be slow and hesitating unless the whole community, and especially the working-classes, can be assured that the purpose in view is the general welfare, and not exploitation. Almost within living memory, new scientific inventions caused such grave misgiving to the working-classes as to induce them to wreck the new machines by which they thought their livelihood was endangered. This mistrust survives in other forms and manifestations. It ought to give place to a spirit of sympathy and co-operation with the progress of science, in all departments of human thought and endeavour.

In the confident hope that the addresses at the Conference would contribute to promote this spirit, the Guild has undertaken their publication. Our thanks are due and are tendered to the distinguished representatives of Science and leaders of the Labour movement whose contributions are included in the book.

ASKWITH,

October, 1924. *President, British Science Guild.*

CHAPTER I

THE PLACE OF SCIENCE IN GOVERNMENT

The addresses printed in this chapter were given at the First Session of the Conference on Science and Labour held at the British Empire Exhibition, Wembley, on the 30th May, 1924, Sir Richard Gregory, D.Sc., in the Chair.

Sir RICHARD GREGORY, D.Sc. : I much regret to say that, on account of urgent public business, the Prime Minister is unable to preside this morning. He has, however, sent a letter which expresses so eloquently his views as to the objects of this Conference that you will be, as I certainly am, most grateful for the encouragement he has given. He writes :—

10, Downing Street, Whitehall, S.W.1.
28th May, 1924.

Dear Sir,

I am so sorry that a Cabinet Meeting will prevent my attending your Conference at Wembley at 11 o'clock on Friday morning. I have been looking forward to this meeting with great pleasure, as I wished to try to say something to impress upon the public the necessity of treating political questions in a scientific spirit, and not merely in a short-vision, partisan frame of mind. Until we regard administration and legislation in precisely the same manner as a scientific worker approaches his work in a laboratory, we shall never be able to get results of a permanent character, nor shall we secure respect for our public institutions. I was hoping that one of the results of the war would have been to have eliminated from the House of Commons the ' methods of the dog-fight.' Unfortunately, there are far too many signs that the hope is not to be fulfilled. The matter ultimately rests with the public, which ought to scan with scrupulous vigilance proceedings in Parliament, not merely in relation to this topic or that, but to the spirit of national concern which its debates show. If our social organisation is still so very rudimentary that the public are open to the exploitation of any interest that is placed for the moment in a position of economic advantage, it is mainly owing to the fact that scientific methods have hardly yet been applied to Society itself. I hope that as a result of your Conference a beginning will be made in the scientific consideration of the problems which confront Parliament, and, if that happens, the promoters of this Conference will have great cause to congratulate themselves on what they have done.

Yours very sincerely,
J. Ramsay MacDonald.

T. Ll. Humberstone, Esq., B.Sc.

We could not have hoped for a more appropriate introduction to this Conference than that which the Prime Minister has so kindly given us by this letter. It represents entirely the objects in view of the promoters of the Conference—the British Science Guild and the National Joint Council. The Guild exists in order to extend interest in science, and the use and application of scientific methods in national problems and in all public affairs. I should like it to be clearly understood that in using the word "science" I do not wish the word to be taken to mean merely the experimental sciences of physics, or chemistry, or biology, but the whole range of knowledge ascertained by systematic inquiry, accurate observation, and careful conclusion. When that view of what science means is accepted, it is clear that, not only in the domain of Nature but also in the field of man's activities and man himself, scientific methods must be applicable to all the conditions which influence progress. The experimental sciences are concerned with discovery, with adding to knowledge, and this knowledge frequently has led to the creation of new industries, and must do so even more in the future than in the past. Wealth is created eventually by scientific discovery. In the political field the chief consideration is usually given, not to means of creating wealth, but to its distribution among those who use the knowledge obtained by science.

It is to be hoped that as the result of a Conference of this kind Labour will understand the scientific point of view, that what scientific men are doing is really of great ultimate advantage, industrially and socially, to modern life. The whole world has been transformed by what science has done. We live in an age in which we are surrounded by the results of scientific achievement. If Labour looks only to problems of the distribution of wealth and does not take sympathetic interest in what is being done in order to create new means of wealth by the development of natural resources, or by the creation of new industries or the extension of old, it will not then be really contributing to progress. I know, however, that the Prime Minister, as a student of science, is very familiar with scientific work and scientific methods. He is almost the only Prime Minister that this country has had who is in a position to know what science may mean to modern civilisation. So that this Conference is being most appropriately held at a time when we have at the head of the Government a man who is both sympathetic and knowledgeable as to what science signifies.

The idea of the Conference originated several years ago, and negotiations were entered into with the view of holding such

a meeting as this. Political conditions prevented its being arranged then, but as soon as Labour came into office, we, as the British Science Guild, approached the National Joint Council, and now we have the additional satisfaction of knowing that we are hand-in-hand with members of the Government who are able to encourage the aims that we put forward originally before Labour became responsible for the government of this country.

One advantage of such a Conference as this is that it can bring representatives of labour and of scientific investigation into contact with one another. Both are working for progress, for the development of the human race and the possibilities of maintaining our people in efficiency and comfort. Science is the creator of knowledge ; the inventor is the applier of the knowledge created in the scientific laboratory and the artisan in the works is using that knowledge in working machines and implements, new processes, and materials. We have in those three—science, invention and labour—the legs of a tripod upon which we can build a noble superstructure in the future, but the tripod cannot stand unless the three really are each and all contributing to its stability.

It is to the future we must look, and for which we must prepare. It has recently been shown that the correct translation of the word " Jehovah " is not " I am what I am," but, " I will be what I will be." It is with that note, facing the future with confidence and hope as to what we may be if we really join forces for the promotion of progress, that I conclude these introductory remarks.

KNOWLEDGE AND CONTROL

Rt. Hon. SIDNEY WEBB, M.P., LL.B. (President of the Board of Trade) : I need hardly say that my presence here this morning is due not only to my interest in the subject of the Conference, but also to the express command of the Prime Minister, that, as he himself could not come, he, at any rate, would not have me also fail.

I had hoped to have been able to spend not only more time at the Conference, but also more forethought in preparing something to say to you. But I daresay you will appreciate that those who are charged with the duties of government at this moment do not have very much time that they can call their own, and I must apologise, therefore, for the somewhat scanty remarks I shall make to you.

I am glad that the Chairman in his opening words guarded against a possible misconception of the phraseology of some of the propositions submitted as a basis of discussion by the organizers

of the Conference. I am sure that nothing could be further from the intention of any scientific man or woman than to assume that science is or could be limited to physical and biological science. "Science in Government" can only mean "the application of trained minds to the business of Government," that is, minds so trained as to be able to appreciate not merely the facts of physics and chemistry and biology but all the problems that arise, and all their conditions and all their inter-relations, in the conduct of modern administration. After all, it remains true, if not as was said two hundred years ago, that "the proper study of mankind is man," at any rate that the essential subject-matter of all government is man in society. Woe betide the Government that concentrates its attention on the facts and sequences discovered and expounded by the physicist, the chemist and the biologist, to the exclusion of all the rest of the universe, of all those other parts of the realm of science which are as yet no better explored than was the physical side of the universe a century ago—I mean that side of the realm of science composed of the psychology and the social organisation of the human species. My friend, Graham Wallas, has shown how much there is of "Human Nature in Politics." I am not sure that, whatever its actual dynamic, whether as a catalyst or as a detonator, its potential dynamic is not as great as that wrapped up in the atom. Nor is what we have to consider merely, or even mainly, the place of the scientifically trained, and, so to speak, professionally expert worker in the government organisation. Surely what we need is to create in the general community a better appreciation of the importance of knowledge of the facts and sequences of the universe and of the value to the community of the scientifically educated men and women.

In this connection I would remind you of some of the things—which we are apt to forget—that the Government has done for science. When I say science I mean deliberately science in the sense of scientific research and the discovery of new truths. I venture to suggest that there has been a tendency in some scientific circles to depreciate unduly the interest which the British Government, as a Government, has taken in science, notably physical and biological science, in its practical applications and the use which it has made of the scientific expert. The Royal Observatory was founded as long ago as 1675 as a Government institution; the Royal Botanic Gardens at Kew in 1759; the Geological Survey and Museum in 1832; and the Natural History Museum in 1881. Talk about the endowment of research! Who can estimate the extent of the original work done with the help of Government

salaries during the past century at Greenwich, at Kew, at Jermyn Street, at South Kensington and Bloomsbury? Why should we forget that Owen and Murchison, Hooker and Huxley, were practically all their lives maintained on official salaries? Nor has this endowment of science ceased or slackened. In the years immediately preceding the War there were established a Tropical Diseases Bureau and the Imperial Bureau of Entomology—this quite apart from the Royal College of Science and the School of Mines—and the State-promoted and State-assisted scientific education. Since the War we have had the foundation of the Department of Scientific and Industrial Research, the Medical Research Council and the Imperial Bureau of Mycology. Before the War also the State was supporting, and since the War it has taken over and largely extended, the National Physical Laboratory in whose creation Sir Richard Glazebrook, one of the speakers at to-day's Conference, played so great a part.

What is true is that the War brought home to the mind of the man in the street, much more than it was ever brought home before, the necessity of this kind of work, and of its extension. Nevertheless, I am a little doubtful as to the doctrine put forward in some quarters that if scientific men had been brought into closer contact and co-operation with the Government before the War we should have escaped many of the difficulties which we experienced. For, with all deference to the physicists, chemists and biologists, two things are I think clear. The first is that, though there are some striking exceptions, scientists generally have in the past been disposed to keep themselves in a state of academic detachment, and secondly that in scientific fields, as in others, concentration of the worker on his own particular work frequently results in a narrowness of outlook which seriously diminishes his value, even in deciding problems of national action, to say nothing of national leadership.

Now I want to say that as a humble member of the Labour Government—and I am sure I can speak for the Prime Minister, and, I believe, for most of the heads of departments—I am alive to, and the Government is particularly alive to, the necessity of bringing all the resources of science and all the aid of scientific men in the widest sense to bear on the problems of government and especially, if we may be practical, to assist in their solution. Of course it is not for Ministers themselves to deal with scientific problems, but I hope you will not imagine that the Government for which I am speaking is going to be backward in its recognition of what we sometimes call "pure science,"

although we do not lay claim to any better scientific education than our predecessors. Everybody must to-day be thoroughly impressed with the fact that sometimes the most apparently useless discoveries turn out ultimately to have the greatest possible results. I am still on the look-out for a discovery of any knowledge that is useless. I do not know of any useless knowledge. If anyone is going to stigmatise any knowledge as useless I think he is really telling us something about himself and his own education and nothing at all about the knowledge which he thinks is useless.

I do not think that it can be maintained that the State has, as a general rule, abstained from utilizing scientific ability where that ability is combined with appreciation of the conditions in which it has to be applied practically to the life of the community. A striking example of the utilization of such ability is the work of Sir John Simon in respect of public health administration during the period of 1855 to 1876. That administration is, to a very large extent, the foundation of all our public health administration and it has had perfectly marvellous results in lengthening life and diminishing the death-rate, and I think we may say also in alleviating, as well as in diminishing, the amount of sickness which has prevailed amongst the community. That utilization of the services of Sir John Simon I simply give you as an instance beyond all controversy of the way in which science in the highest sense can be utilized in the machinery of Government. Here, indeed, we raise the whole question of the place of the expert in administration.

I have ventured elsewhere to say that the fundamental difference between English and Prussian Local Government is that the former is based on the principle of lay administration tempered by expert advice, while the latter has been in the past based on the principle of expert administration tempered by lay criticism; and on the broad view of the results I have very little doubt that the former is the preferable principle. I confess that my own studies and my own experience on this subject lead me very emphatically to come down on the British side. I want the layman at the top; I do not want the expert at the top. I want the expert to be there and I want him to have full scope and to be always suggesting and helping and criticising, but on the whole, at any rate in a democracy, you have to leave the control of policy and the ultimate word to the layman. Connected with the London County Council—where I had many years of hard work and administration—we had a great Public Works Department run by a Works Committee. That Public Works Department went on very successfully, in spite of a good deal of

abuse, until we got a lot of practical people—people who knew about building and such matters—actually made members of the directing Committee. Then it went wrong. We got the expert in the wrong place. I think that you must allow the layman with all his faults and shortcomings to be at the top. The place of the expert is always at the elbow of the layman, whether the layman be a Minister of the Government or the Chairman of a Committee.

When you come to the legislature, it is suggested that "the legislature cannot be fully effective without the presence of men or women of high scientific training and experience." If this means that provision ought to be made for scientific membership of the House of Commons, I can only say I am afraid when you look at the characteristics of modern constituencies that there is a certain air of futility about the proposition. I have only sat in the House of Commons for eighteen months, so that my remarks have no reference to any existing Member of Parliament. They are not personal to anyone in the present House or to the people with whom I sit. But I have known a few distinguished men of science—mathematicians, chemists, physiologists—who in the past have by some happy chance obtained seats in the House of Commons. I am not sure that an impartial observer would say that they were at all so distinguished in the House of Commons as they were in the work of science to which they had given their lives. To put it shortly, I think they were seldom, if at all, distinguished for their success in the House of Commons. I would like to add, to show my freedom from bias in the matter, that the same might be said of some distinguished historians and economists. Of course, it could equally well be argued that definite provision ought to be made for inclusion in the legislature of experts in political science, economics, finance and all the other departments of knowledge that affect the life of the community. I am very doubtful about that. I do not want to exclude the man of science—especially if he becomes a member of the Labour Party and fights a constituency ! I may say we should welcome him most warmly, and it might be that he would turn out as successful as a Member of Parliament as he has been in science. But I think you must say, judging from past experience, that the chances are rather against it. It is a different business.

In my view the function of the elected representative is essentially that of an expert exponent of the will of the people and translator of that will into deeds. His task is twofold. On the one hand, he has to be perpetually discovering, and explaining to the scientific expert in the art of administration, what it is that the people lack and wish.

That is not an easy job because, mind you, the people do not say it. The people are very inarticulate and when they are articulate it is only an indication to their trained representative in Parliament that the shoe pinches. He takes their demand for a new shoe not as evidence of the kind of shoe that is really wanted or what the public really desire, but as merely their way of expressing the fact that the shoe pinches. It is for the expert representative to discover from the statements of the public what it is they really lack, and what it is they really wish when they ask for something. He has to translate that with the help of the scientific expert in administration with whom he has to deal. On the other side he has to convey to the popular mind what the administrative expert, after consultation with the physicist, the chemist, the engineer, and even the biologist, reports about the practicability, the method, and the probable reaction of this or that project of social reorganisation.

Now that is a very difficult job, this task of the elected representative. I very much sympathise with what the Prime Minister has said, indicating his wish that we had more scientifically-trained elected representatives or a better scientific training of the elected representatives. I venture to suggest that their training for this job which I have been describing would have to include as the most essential part a training for discovering, explaining and translating popular needs, and that, of course, is not the job for which the chemical laboratory or the physical laboratory necessarily trains the physicist or the chemist or the biologist. I am not saying that your expert representative, like every other educated man, does not need training in the methods and conceptions of physical science and also of biological science. That he wants, and that I think ought to be part of every first-class education. But I think the elected representative that it is suggested we should ask from the world of science must have more than that. He must in addition have a training in his own particular art, the art I have been describing, which is very difficult to get. I am not sure whether specialisation in physical or biological science is the best preparation for that. Some people will tell you that the Greats School of Oxford would be a much better preparation. I am no more in agreement with that view than I am with the other. I will not tell you my own view. You might inquire at the London School of Economics.

There is much more to be said about the place of the scientifically-trained man—and here I say quite frankly I mean the man who is trained in chemistry, physics and biology—in the Civil Service. We want well-educated men in the Civil Service just as we do in

the House of Commons, but we want also, I think, a good deal more training in physical science in the education of the Civil Servant. I do not mean merely more than he is getting at present or than he has got in the past, but a great deal more than can be asked for in the training of the Member of Parliament. A Member of Parliament does not need to know very much about electricity ; he can get his electrician and as much expert advice on that subject as he needs ; although, of course, he does want to understand something about it. But the Civil Servant has to have a much better expert knowledge than that. If I had the time I should like to plead at greater length for a great deal larger recognition of the place of physical science in the education of the man who is going to be a servant of the State in any of the higher ranks of the Civil Service. I was a Civil Servant myself somewhere in the middle of last century, and so I have had an opportunity of observing the government machine from the bottom. It is extraordinarily interesting now that I am nearing the age of retirement to come in at the top, and see the machine from the other end. I will say no more than that I am enormously impressed with the ability and the loyalty and the administrative skill and knowledge of science possessed by our principal Civil Servants. I am now more than ever convinced that we have got the best Civil Service in the world. Do not let us be too severe in our criticism of them for not having enjoyed all the training in physical science that we should now devise for them. They have managed to get that all-round education which is a very good basis, and when I say that there might be more physical science in the training of the Civil Servant than there is at present—and especially than there has been in the past generation—I can only say that our Civil Service has managed to attract to itself a considerable proportion of men who have had a good deal more scientific training than the average individual.

Now the fundamental problem seems to me to be, as I have said, the creation in the community of the recognition of the importance of expert knowledge, and the creation of an atmosphere which will encourage research in all departments of knowledge without regard to immediate practical results. No Government can do very much in that direction unless we do get that diffused public opinion, and I think we are gradually getting it. You will say, perhaps, that this is a platitude—a platitude being one of those truths which everybody accepts and nobody acts upon. But I will end by giving my platitude a more provocative and as I think a more precise application. I speak to you as a member

of one of the political parties, but I wish to couch my proposition in wider terms. There are, we have been told for 2,000 years, three main types of government—autocracy, aristocracy and democracy. It seems to me that it is especially the democratic form of government that most obviously and most demonstrably depends on the fullest possible development and utilization of science. Certainly the Labour Party has no belief in any of the problems of the world being solved by goodwill alone. Goodwill without knowledge is warmth without light. Especially in all the complexities of politics, in the still undeveloped science of society, the Labour Party stands for increased study, for the scientific investigation of each succeeding problem, for the deliberate organisation of research, and for a much more rapid dissemination among the whole people of all the science that exists.

It is perhaps specially the Labour Party that has the duty of placing this advancement of science in the forefront of its political programme. What the Labour Party stands for in all fields of life is, essentially, democratic co-operation; and democracy, involving as it does the widest possible co-operation, involves a common purpose which can be agreed to, a common plan which can be explained and discussed, and such a measure of success in the adaptation of means to ends as will ensure a common satisfaction. An autocratic sultan may govern without science if his whim is law. A plutocratic party may choose to ignore science, if it is heedless whether its pretended solutions of social problems that may win political triumphs ultimately succeed or fail. But no democratic government can hope to maintain its position unless its proposals are, in fact, the outcome of the best science of its time; or to fulfil its purpose unless that science is continually wresting new fields from human ignorance. Hence, although the purpose of a democratic government must, by the law of its being, remain for all time unchanged, its policy and its programme will undergo a perpetual development, as knowledge grows and as new phases of the social problem present themselves, in a continually finer adjustment of measures to ends. If law is the mother of freedom, science to democracy must be the parent of law.

SCIENCE AND SERVICE

Sir RICHARD GLAZEBROOK, K.C.B., D.Sc., F.R.S.: I need spend but little time in discussing the duty of the State to foster science. The President of the Board of Trade has not merely admitted the duty; he has brought out very clearly its importance and indicated his own feeling—shared I trust by his colleagues—as to the responsibility resting on the Government.

I am here to speak from the standpoint of one who has devoted his life to experimental science. The scientific societies interested in chemistry have prepared a handbook for their exhibit which opens thus :—" If a dispassionate comparison be made between civilisation as it is and as it was in the days of the Roman Empire or in still more ancient Egypt, it will be found that whilst there has been but little progress in art or in literature or in politics, either civil or national, there is a complete change in the life of the world as the result of the development of scientific method and its practical applications." Some may criticise the first statement of this sentence, all will agree with the last.

Thus it follows that Governments are concerned with fostering the progress of science and utilizing its advances for the betterment of the community. How can this best be secured? Is our Government doing all it should? Can we as scientific men help it to do more, guide the steps of our legislators in the right track, and make their efforts more fruitful for the people? Now let me say at once I am not ungrateful for what has been done. The change in the last twenty-five years since I started work at the National Physical Laboratory has been enormous. We commenced in 1900, a body of fifteen in all, with a Government grant-in-aid of £4,000, a total expenditure of £5,479. The staff now approaches 600. The estimates show that the total expenditure is about £170,000, while it is anticipated, I gather, that to set against this the work for which payment is received will approach £100,000.

The Department of Scientific and Industrial Research is a comparatively modern growth with its co-ordinating boards, its research associations and its other activities. Personal experience has shown me the value of much of the work of the research associations. In numerous cases they are bringing to the solution of technical problems the results of profound science.

The Admiralty has its laboratory at Teddington, its signal school, and its research stations. Those who listened to Mr. F. E. Smith recently at the Royal Institution will have realised a little of what science is to the Navy. The Army has its scientific investigators and has learned from war experience its dependence on science. Take for example, the problems of gunnery, especially anti-aircraft gunnery and the work of A. V. Hill, sound-ranging developed by Bragg, methods of communication, wireless and the like. The Air Force again, since the days when by the foresight of Lord Haldane the Advisory Committee for Aeronautics was established, has maintained its close connexion with science

and in its laboratories at Farnborough and elsewhere has carried out numerous scientific investigations which led to British supremacy in the air. The Board of Trade has recognized dependence on science by entrusting a fundamental part of their work to the National Physical Laboratory. Let me beg my hearers, if they have any doubt of the value of science to Government at present, or are ignorant of the extent to which it is being used, to pay a visit to the Government Pavilion in this Exhibition: a few hours spent there will convince them that there has been, to quote again, a complete change in the life of the world and in the methods of Government due to the development of scientific method and its practical applications. While fully realizing this we still ask for more; not for ourselves as men of science but because we know we possess a pearl of great price and we wish the nation to share in the glory of that possession.

There is an article in last week's *Nature* on "Science and the Future." Let me quote a few words:—"However much Governments or individuals may attempt merely to utilize the practical results of science they cannot have those results without men of science, and they cannot have men of science without the scientific spirit." And again, "The scientific spirit is that which finds out what is true and attempts to act on what it has found out—rational imagination and imaginative reason."

What can we do to foster the growth of the scientific spirit in our Government? How can its members show that they appreciate that spirit and are prepared to place men of science in a position to render the highest services to the State? In reply to the first question, something may perhaps be done by the presence of men and women of scientific training in the Legislature, and by inducing scientific men to take an active part in social and industrial organization, but more will come from education, from bringing home to the ordinary man of the world his dependence on science, by interesting him in the wonders and beauties of Nature, by teaching him through an Exhibition like this what he owes to science. Let him go to the Royal Society Exhibit in the Government Pavilion and learn there how the desire to know, to fathom the secrets of Nature, and to unfold its mysteries, led the great men of science to the discoveries which have revolutionized the world and given him the amenities of modern life. We need votes, and they can be secured only by widespread educational effort. And to come to practical details I would urge those in authority to remember how delicate a plant is discovery, how priceless an asset is the genius of the discoverer.

The man of science working for the nation must have his freedom and be untrammelled by rules and regulations which may be necessary in other walks of life. "The wind bloweth where it listeth. thou hearest the sound thereof but canst not tell whence it cometh and whither it goeth"; so is the man inspired by the true spirit of science. The problems which call for solution are many and various. If the Government find a man capable of dealing with one of these, let them give him the facilities he needs and leave him to his work; he may not solve your problem but he will almost certainly find the answer to some other of equal importance. Do not burden him with rules; time-sheets and methods of costing are an abomination to such a man. Give him freedom within due limits as to his expenditure. Treasury rules were made for other circumstances, and some other means can surely be found to maintain the rights of Parliament and safeguard ministerial responsibility. Some one has said, and it is true of the scientific worker, "When I wander here and there, then do I most go right."

This afternoon we are to have a discussion on Science and Industry. I trust one at least of the speakers may be able to support, from the industrial standpoint, what I have said as to the importance of freedom. Again let me emphasize another point. Scientific investigations may be divided into two classes—the one relating to fundamental problems in pure science, the other to applications of science to a definite problem of government. It is the first of these classes which it is most important to foster; the applications will come when once the principles are understood, and progress will be slow until they are understood.

Let me take an illustration from the growth of aeronautical science. In early days before the War, the Advisory Committee for Aeronautics, guided by Lord Rayleigh, was greatly interested in the principles that underlay the true phenomena of flight, the laws of air resistance investigated by experiments in wind tunnels, the problems of aerodynamics, the conditions of stability in flight, and, as a result, when the time of trial came we were far in advance.

An American authority in a recent official report writes: "The marvellous achievements during the late War would have been impossible without the experimental work done at the National Physical Laboratory and at the Göttingen Aerodynamic Laboratory. The underlying reason why so little progress has been made in design since the War is that there has been so little added to our knowledge of aerodynamics in recent years owing to the lack of financial support given to work of this kind not only in this country [America] but in all the countries of Europe." This is true

and to his true statement there is a sad corollary. But a small part even of that small addition to our knowledge has been contributed by this country. Prandtl and his school in Germany, and in America the National Advisory Committee for Aeronautics, have been responsible for the larger share. Here of the money available, most has gone in the applied part of the work—the claims of the development of some promising engine, for the testing of some safety device, for the investigation of an unsuspected defect in a machine—and such *ad hoc* problems have outweighed those of pure science and we are being left behind, not because the authorities are averse from the advance of science or do not realize that real progress rests on this, but from the method of organization —the daily pressure of urgent needs and the absence of a man whose sole business is to see that the claims of pure science are not set aside.

The present Air Member for Supply and Research is as fully aware of this as I am and as anxious to remedy the defect. So was the late Secretary of State to whose action we owe it that the duties of Director of Research are now to be discharged by two officials—a Director of Development and a Director of Research. We await anxiously the appointment of the latter. One word as to his qualifications and position. He must himself be a distinguished man of science, one who has carried out with success important researches. Thus only can he gain the confidence of his staff, appreciate their difficulties, guide the direction of their research and appraise the value of their results. To do this he must himself have tasted the pleasures of successful inquiry, at first doubt and uncertainty, a struggle for more light when the first gleam of truth appears, then the sudden realization that the answer long sought for has been found, and the delight of complete discovery. Such men are rare ; they always have existed in our country, they exist still.

But in addition the position offered must be one which such a man can take. He needs the assurance that fair play will be given him for his discoveries to bear fruit, that he will have the opportunity of putting the results before the highest authority, and that after they have been approved he will be in the position to secure that they should be applied.

Official wheels grind slowly ; it is easy to put a few grains of dirt in the cogs and check the machine. Red tape is too often fastened in knots hard to untie, and until it is realized in the highest quarters that science is essential and must be free we shall lag behind. I have illustrated my theme by a reference to research in aeronautics because I know of this, but my conclusions are general.

This Conference will have done well if it can impress upon the Government the need for research in pure science, guided by men who are free to follow the lines along which their investigations lead them; secondly, the importance of securing such men for Government service, leaving them free and unrestrained as far as is compatible with ministerial responsibility to Parliament; and, in the third place, the necessity that such men should hold positions in their country which will secure to them the power to translate their discoveries into practice.

SCIENCE IN ADMINISTRATION

Major A. G. CHURCH, M.P., D.S.O., B.Sc.: The revolution which took place in men's minds towards the end of the eighteenth century was essentially a revolution which was produced by the scientific minds of the time. One can attribute the origin of the French Revolution, not from the point of view of its enthusiastic horrors, but from the point of view of the better flights of its imagination, to the French encyclopaedists, men of the type of Diderot and Carnot, for whom the terrorists had no further use once they had tasted blood. Consequently, the scientific men who succeeded them kept away from anything like social and political science and devoted themselves entirely to the creation of new wealth for other people—not for themselves.

I cannot agree with Mr. Webb in his attitude towards scientific men in Government, because I think that if we had a few more scientific men in the House of Commons at the present time—men who knew what they were speaking about when dealing with scientific subjects—the country would be able to pay more attention to the things which are really vital and the problems which have to be faced and overcome. I refer more particularly to problems such as housing, unemployment, and finance, which represent the real life-blood of the country and which at present are being discussed by men who, from my short experience of them, have about as much chance of finding a solution as the metaphysician who was described by Mr. Baldwin as someone searching in a dark room for a black cat which wasn't there. One is struck by the profound ignorance of the present Members of the House of Commons in regard to the real advances which have been made in knowledge in the last two decades. They measure the advances in science by the advances which have been made in the application of science. They still regard the palmy days of science as those four and a half years of warfare when science was being applied, forgetting altogether that if ever there was one period in the history

of this country and of other modern nations when science was being neglected—that is to say, the creation of knowledge—it was during those very four and a half years. The creation of knowledge during the period of the War was not proceeding at anything like the same rate as it had been proceeding before. We were certainly applying the knowledge which we had, and applying it successfully, and we may assume that if we had continued to apply our knowledge to the problems of peace with the same energy and enthusiasm that we applied it to the arts of war, we might have got to the end of our troubles a long while ago, or at any rate been within sight of solving some of the most important problems.

Sanderson, the late head master of Oundle, who died two years ago, summarising the situation as it existed at the time of the industrial revolution, said that you then had a period when the more active spirits of our generation were applying the discoveries of scientific men with the sole idea of acquiring wealth to themselves. Then followed the period notorious for unrestricted exploitation of children in industry. There was a third phase, the unrestricted rush for production irrespective of the effect of over-production, or of unscientific production, upon the nations of the world. That was followed quite recently by the creation of a new applied science known as industrial psychology. I am not suggesting that industrial psychology is not one of the fundamental needs of the time ; I believe it is, but if it is going to be merely accentuated Taylorism, as applied in America, it is going to be one of the curses and not one of the safeguards of civilisation. It will produce a nation of Robots, and if one can envisage the future as the playwright can, we know what will be the end of civilisation. H. G. Wells has given us a fairly accurate picture of where the unrestricted exploitation of human energy will bring us if wrongly applied and misdirected. That is what I fear from the machinations of the arch lay administrator. He has no concern with the right application of science ; his concern is more with its application and to the creation of wealth. What is needed is not the restriction of the expert by the lay administrator, but more administrators with a scientific attitude of mind and a full appreciation of the value of science.

The first products of industry must be for the worker. If that idea is to be accepted it will change our whole conception, not only of industry, but of running the world on a scientific basis and applying science rightly. Civilisation exists not for the exploitation of the many by the few, but for the exploitation of the natural

resources of the world so that they shall be distributed amongst the people, and so that the things which are made by the people shall be used by the people who make them. It is one of the strange commentaries on our civilisation that people who are producing the most beautiful things never use them or enjoy them or wear them, but are invariably making them for the use and enjoyment of others. The fruits of their labours are denied them under the present system. I am not condemning any one political party or suggesting that the Labour Party has an outlook on these questions fundamentally different from that of any other party. I do not say that the Labour Party is composed of super human beings. Probably we have men of all parties who are regarding life at the present time from the point of view of how largely they can exploit civilisation and their fellows, rather than how much they can serve their fellows. From my knowledge of the various political parties I say: "Give the highest number of marks to the party which contains the largest number of men who look upon this subject of the exploitation of the world's natural resources from the point of view of bringing them within the reach of all, so that mankind shall be happier and better, physically, mentally and spiritually."

That is the function of science, and I should assume it was the function of Government and the scientific men in any Government institution or any Government itself. You put your scientific man at present in a position of hopeless subservience to lay control. You allow the Treasury which is staffed by men—I speak from some experience—who probably had a scientific outlook before they went in, but who soon lost it, because there is no more soul-destroying department in the whole of the State than that department which concentrates all its endeavours not on providing money for wise expenditure, but upon the uncontrolled cutting down of expenditure irrespective of the relative merits of that expenditure. To subordinate a spending department to financial control is a thoroughly sound principle for any State to adopt, but to subordinate a spending department—particularly a scientific department—to financial control exercised without any scientific spirit whatsoever, is a fundamentally bad thing for the country, and that is what is happening at the present moment. You have an administrative system which has grown up, based entirely, as Mr. Webb has said, upon the Greats School at Oxford, with men of a definite type of mind. Do not think that those men have gone—they are going. Do not think that they are easily superseded—they are not; their influence is still there, and although

the man with that type of education may go, it will take many years for that type of mentality which is engrained in the staffs of the departments to be rooted out.

We have to do our best with the machine as it exists, but we must have more and more administrators, as Mr. Webb has already said—with a scientific training and outlook so that they will know when to interfere with the scientific and technical expert and when to leave him alone. It is an absurdity, at the present time, for the Treasury or any lay administrator to say to the scientific head of a department: "We want you to solve a particular problem and we will give you so much money to do it with," and then ask that person to put up various schemes which are going to be criticised in detail by men who know nothing about them. That is what is happening. Again and again one gets this complaint from the scientific heads of departments. Sir Richard Glazebrook has told you that the present Air Member for Supply and Research on the Air Council is a man who recognises to the full the value of scientific research in his department and wants to encourage it to its utmost. I dislike to disagree with Sir Richard Glazebrook, but my experience has been the contrary. Two years ago, acting in the capacity of Secretary of the Union of Scientific Workers, I pointed out to him certain developments that were bound to take place in the Air Services within two years, and assured him that he could not cripple his scientific staff without seeing the fruits within a year or so. Regardless of that, bowing his knee to the claims of the superior authority, the Treasury, he said: "We must economise." One of the first ways in which you economise always in a State department is to cut out your experts. You can cut out the experts, but you must have your lay administration even although there is nothing to administer.

Although you will have gathered by this time that I have considerably more freedom and less responsibility than other people who have spoken this morning, it is hardly my function to enter into a protest against the various faults I see in the present system, but I do say that the present system will continue to provoke the utmost dissatisfaction amongst the men working under the system. The scientific man has been subordinated to ignorant lay control. He would not object to knowledgeable control, but he does object to men playing havoc with his schemes who know nothing about them, having only a detachment of view which the scientific man, through not being able to look at things from only one angle, can never hope to attain.

May I conclude by referring to the remarks in a leading article in *The Times* of 30th April. The writer was discussing the relative merits of the Poor Law hospital system and the voluntary hospital system, and he preferred the voluntary system, suggesting that it should give any member of the Labour Party with ideas in the direction of the nationalisation of hospitals occasion for further thought. The real fact of the matter is this, that the medical profession in the voluntary hospitals have a large measure of control over their own destinies and over the work they are doing, and there is no reason at all, if you constitute your administrative departments properly, why you should not have the same control exercised by the scientific man over his own activities. We have had an eloquent plea from Sir Richard Glazebrook, a man who has had considerable experience in one of the greatest scientific institutions in the country and who knows what it is to be hemmed in by petty regulations in regard to costing systems and things of that kind. He has made an eloquent appeal really for the freedom of scientific men from this unnecessary interference. You have got that freedom in your voluntary hospital system. I am not claiming that under a nationalised system, at the present time, we should get any better work out of the hospitals than we do under the voluntary system. Indeed, I think we should not, because under the voluntary system those in authority realise that they have to leave their medical men in charge of affairs and leave them to work out their own destinies, and, unless the State gave them the same degree of freedom, the State would fail and we should soon be longing to return to the old voluntary system. It is no argument in favour of the nationalisation of such institutions to say that the Poor Law hospitals are badly run. At present they are badly run because they are under lay bureaucratic control which has no knowledge of disease and medicine and the proper system under which the hospitals should be worked. That is the trouble.

The Medical Research Council differs from most scientific institutions inasmuch as it is controlled almost completely by members of the medical profession or of the scientific profession. I want to see—and I can assure you I am going to fight for it as long as I am in Parliament—the scientific man being given the same control over his destinies as the medical man is given. We want, if we can get it, a scientific council which is going to be given a certain amount of money yearly for scientific research, and which is going to control its expenditure without unnecessary interference. We do not interfere unnecessarily

with the expenditure of money once it has been granted to the Medical Research Council. I am one of that body, so I know something about its working. We give a man money and entrust him to carry out the task which he has set himself to do—giving him tasks which we think are most essential to be undertaken for the progress of science and for the uplifting of humanity. We can apply the same doctrine with regard to science in every respect. We want a central scientific council which shall be given funds and power to disburse them, and that body would be the proper body to whom any State department would go for the best scientific advice. Not until then will the State get the best from its scientific workers, and not until then shall we see the dawn of an era which will be regarded by future generations as one which counted the welfare of all its peoples of more importance than the private fortunes of a few individuals.

DISCUSSION

Mr. GEORGE D. HARDIE, M.P. : As a member of the House of Commons for eighteen months, and coming fresh from industrial research, I can speak on this question as a practical man. Mr. Webb has said that the lay mind must always be the mind that must make the choice from the products of the scientific mind. He claimed that this was necessary to eliminate bias. But did not Members of Parliament owe their seats to their political bias ? When Mr. Webb suggested that the layman was to have power over the products of the scientific mind, I could not help thinking what a wonderful mind he will have to possess. The conceit of the lay mind that suggests that because it has not the knowledge it is capable of deciding upon things it cannot conceive is ridiculous ! I am afraid there is too much of the politician getting into the realities of life. When Mr. Webb said that men of science had not distinguished themselves in Parliament, I thought it was because they were not gasbags. I recollected one occasion in the House of Commons when a question came up about the manufacture of gas mantles—a simple question to any person with a little scientific knowledge—and a scientific discussion ensued. What happened ? I was one of five left in the House to take part in the discussion. On another occasion there was a discussion on the question of charging for gas by the therm instead of by the cubic foot, and there were seven present. The lay mind was downstairs in the smoke-room. I for one have been fighting the cause of the scientist and am going to continue to fight until scientific men take their proper places in the government of the country. In the past

we have sneered about fox-hunting squires being returned to Parliament and made Ministers of State and given control of mines and so forth, men without any knowledge of science or of the conditions under which miners work. Now we are told that we cannot have a scientific man in such a position because of the bias his knowledge gives him. The hypocrisy of it !

Professor L. BAIRSTOW, F.R.S. : The point I wish to make this morning is on one fringe of the subject already dealt with by Sir Richard Glazebrook and Major Church. In a notice of this Conference I find an item for discussion which reads : " In order to make science effective in national affairs, all boards or councils in which scientific factors are of importance should include members of scientific training and experience." That is the only point on which I propose to speak. I wish to support the plea particularly as applied to councils of State ; but, in view of what happened in the newspapers last week in the public discussions of the " death ray," I would like to extend the field to cover the editorial staffs of certain newspapers. The newspaper articles have had one good effect, however, in that they have drawn from a former Cabinet Minister, Lord Birkenhead, a rejoinder in which he takes up a standpoint very much in accordance with what scientists would wish. He concludes his article by saying : " I myself most strongly support the views of those who insist upon the fullest possible scientific voucher before handing over public money to a scheme so fantastic." How are we to get the fullest possible scientific voucher without the man of science in a position of primary responsibility ?—some man who in the council of State can go to the Minister directly, and from his own knowledge say : " This is fantastic." There are all sorts of measures of fantasy ; some of them, like the death ray, are very easily dealt with by the scientific staffs already in Government departments, but there are others that are very much more difficult. For instance, it would be a great advantage to Government departments concerned in scientific work if they had a man in the highest councils of State in charge of scientific research who could say : " You will stifle scientific work if you try to run it on a factory organisation designed for the production of goods in large quantities." Yet I think I am correct in saying that we have not a single department of State in which such a man exists.

Sir Richard Glazebrook has referred to aeronautics—that is a subject in which I have most experience. I shall refer also to aeronautics for my illustration. I have been connected with aviation for some sixteen years and, as was pointed out in the

Memorial Lecture to Wilbur Wright last night, flying has only been in existence for just over twenty years. During that time scientists have always been used in an advisory capacity and the great difficulty has been to get from advice to action. The difficulty, translated into a definite statement, has been that among the executive heads of the department of State concerned we have had no people in primary authority with a personal and intimate knowledge of science. We have had, as Sir Richard Glazebrook has pointed out to us, full lay sympathy, but in my opinion that is not sufficient to give the State the full benefit of the scientific knowledge which exists in the country. At the moment the Air Ministry has decided to have a Director of Scientific Research. We have a Director of Scientific Research in the Admiralty; and the War Office, the Post Office, and other Government departments have scientific men on their staffs, but I think I am well within the mark when I say that no Government department at this time offers serious attractions to scientific people of outstanding ability. The prospects of promotion are inferior in almost all cases to those of the financial administrator, say, or, in fact, the administrator of any other branch of Government activity. The result is the very natural one that Government departments are weak in dealing with new knowledge. In order to encourage the requisite scientific people into the Government, it seems to me essential that scientific staffs should be grouped under a responsible scientific head—a head responsible to nobody but the Secretary of State.

To take a rather more particular case before I close, may I refer to the safety of aircraft? Aircraft are reasonably common nowadays, but anyone connected with aviation trying to effect an insurance policy finds flying regarded as a dangerous occupation. All aeroplanes—I am speaking of the world's aeroplanes, not British—have certain defects which make them dangerous. Those defects are known, and have been known to the Aeronautical Research Committee and its predecessor for many years, and I think for the last five years the investigation of the defects has been given a priority in its recommendations, and yet, because of the unscientific organisation of the executive side, our progress towards the safety of aeroplanes has been meagre. Things are improving, but for full progress I think we need not only a scientist as Director of Scientific Research, but also a man of science on the Air Council in direct contact with the Air Minister.

Mr. T. LL. HUMBERSTONE, B.Sc.: I should be sorry if the statement of the President of the Board of Trade with regard

to men of science in Parliament were allowed to go by without challenge. We have to remember that few men of science have tried to enter Parliament, but of those that have, I think it only fair to say that some have certainly done good work. Two names occur to me, Playfair and Sir John Lubbock. In another department of public life, I would instance the work of Huxley as a member of the London School Board. A year or so ago I worked hard to secure the return of Mr. H. G. Wells as Member of Parliament for the University of London : but I am free to admit that I had some scruples whether Mr. Wells's time could not be better spent in other occupations than pacing the division lobbies of the House of Commons. It is not so much a question whether men of science would be useful in Parliament as whether their energy and ability would not be more profitably employed elsewhere.

There are obviously two main aspects of this discussion—one, the scientific attitude of mind in public affairs, and the other the actual work of men of scientific attainments. I should be disposed to emphasise the question of the scientific attitude of mind in administration and legislation rather than the other aspects of the question which have been discussed this morning. What is the scientific attitude of mind in public affairs ? Is it not freedom from prejudice, a willingness to examine anew every issue, every theory, to question every principle however well-established, with the view of arriving at a closer approximation to the truth, and a willingness—which our particular nation is not sufficiently disposed to display—to scrap old machinery and obsolescent methods.

There is nothing permanent in science. Moral laws may be permanent but scientific laws are not necessarily permanent. Even Sir Isaac Newton must have turned in his honoured grave when Einstein appeared on the scene. It is extremely necessary in our old civilisation that established systems and practices should be re-examined from a scientific point of view. In the very limited time which can be allowed to non-Cabinet Ministers in this discussion, I cannot, of course, attempt that survey here and now, but there is one question of primary importance on which something has already been said by Mr. Webb and other speakers, and that is the methods of recruitment of the Civil Service. The system of competitive examination introduced in mid-Victorian times for the selection of the higher Civil Servants is entirely out of date and ought to be scrapped immediately. It was introduced to guard against an immense amount of nepotism and favouritism which was shown in those days in the appointment of our public servants, but to-day, as a system, it is unscientific in its methods

and in its results ; it has favoured unduly the classical curriculum and it has not introduced a fair proportion of men of scientific training into the Civil Service. In addition, it has operated unfairly against the graduates of modern universities ; and I hope that the abolition of this method of selecting higher Civil Servants is a matter to which the present Government will give its attention, because I believe that the question of the previous training and the method of selection of our public servants underlies the whole of this discussion.

Mr. RICHARD B. PILCHER : I wish to put forward one concrete example of what has been called " the application of trained minds to the business of Government." Nothing has been said to-day of the great work which has been done by the professional chartered bodies of this country in helping the Government, on all occasions, and especially by appointing representatives to give evidence before Royal Commissions and Departmental Committees. It has been the practice of Government departments in the past to expect " the poor wise man " to give of his wisdom and to remain poor. As Registrar and Secretary of the Institute of Chemistry, I know that the Institute was recently asked to nominate a representative to attend the meetings of a Special Committee, under an important department, in order to give expert advice and the benefit of his experience in a matter of serious public concern. The Council of the Institute nominated a chemist who had had large experience of the matter in question ; but the Government could not see its way to pay even his expenses : so that he was expected to give his time free, the best of his brains, and to bear all the expense. That is the way in which the scientific man is commonly treated by administrators who suggest that he should not be put in a position of control ; and this, while Members of Parliament are paid their travelling expenses and £400 a year.

Major H. E. WEAVER : I should like to see a small body nominated by this meeting to interview the Prime Minister by way of a deputation and to ask him definitely to appoint a properly qualified body to inquire into the present position of scientists in the Civil Service. The present position in the main is in my opinion an abominable one. The Treasury is recruited at present almost entirely from one type of mind. I do not say it is without ability. The recruit is a man who can write wonderful letters which mean nothing, and the English is unblemished, and if there is a scientist in any Government department, he is certainly not at the top, and he never gets in direct contact with the Minister.

If his views are required on any subject he always has to write them, or to explain them, to a man above him who knows nothing about the matter, and this man presents them to the Minister, and acts as the go-between—between the Minister and the expert. The Prime Minister claims to be sympathetic to science. Three months ago the Institute of Chemistry, a body comprising leading scientific men, sent him a letter asking him to look into the difficulties of scientific men in the Civil Service. No answer was received to that letter. A second letter was sent to him by the President of the Institution of Civil Engineers on the same subject, but, except for an acknowledgment of the letter, nothing more has been done in that case either. I think, therefore, and I venture to suggest, that if we could send a deputation from amongst those who are on the platform, and perhaps some of us here, and we could see the Prime Minister face to face and tell him our views on this matter, we might make some impression. I am afraid we shall never make any impression merely by passing resolutions or sending him verbatim accounts of what has been said. It is no good setting up a body inside the Treasury itself. The officials there are bland and courteous and everything that is nice, but that is not the point. The Treasury is really in the position that it can do no wrong. A man comes to the Treasury, possibly destined to rule over the department, and he must, of course, be a clever man, otherwise he would not have been able to produce the necessary qualifications, and, as I have said, he is bland and courteous ; but if he makes a mistake it is always covered up, because the Treasury is like the King—it can do no wrong and you have no legal redress against it except by a Petition of Right ; and also, once he is in the Treasury his career is certain and well-defined ; he automatically goes from one grade to another, and ultimately gets to the top where he has control of men who do the real work of running the country.

Dr. Stephen Miall and other speakers also took part in the discussion.

CHAPTER II

SCIENTIFIC RESEARCH IN RELATION TO INDUSTRY

The addresses printed in this chapter were given at the Second Session of the Conference on Science and Labour held at the British Empire Exhibition, Wembley, on the 30th May, 1924, Right Hon. Lord Askwith, K.C.B., K.C., in the Chair.

Rt. Hon. Lord ASKWITH, K.C.B., K.C. : The general title of this Conference, " Science and Labour," is rather a wide one. It may appear almost as illusive as that celebrated question which was asked by a magistrate centuries ago : " What is Truth ? " And the relations of Science to Labour, overlapping and interlocking as they are, would be almost as difficult exactly to define. But this afternoon we are brought to the more narrow question of scientific research in relation to industry ; and I understand that a great deal of what may be said may lead you to feel that scientific research ought not to be treated, from the point of view of the man in the street, as a mere abstract theory not particularly interesting to him, or as a star, cold and distant, not affecting his life at all, but rather as a subject which may affect his life in the most material manner—his food, his health, the very spirit and beauty of life itself. Therefore it is a subject in which Labour in the broad sense, and in fact all the people of this country and of all countries, should take a keen interest, not only for the effect that it may have on their own lives, but also on the future lives of their seed and their seed's seed, for generations yet to come, so that you are doing something in an unselfish manner, not only for yourselves, but for other people in the world, and for those generations who will be the lasting memorial we may hope of some of us, for ages that we cannot compute.

RESEARCH LABORATORIES AND INDUSTRIAL DEVELOPMENT

Mr. HUGO HIRST (General Electric Company) : I do not know on whom to lay the blame for having selected me for the opening remarks on so academic a paper as " Scientific Research and Industry." I am conscious of my limitations on so intricate a subject. It occurs to me, however, that having been mainly responsible for the creation of the research laboratories of The General Electric Company at Wembley, at a cost of £200,000 and a yearly expenditure of about £50,000, I may be given credit for a deep study and knowledge on the subject. May I therefore emphatically state that the impulse which moved me was not the outcome of deep study, but of practical experience.

I have long held the view that one of the most essential features of an industrial undertaking was a fount of knowledge in the right place, and the right place was at the head, whence by proper channels the fertilizing stream could permeate even to the most remote parts of the organisation.

This conviction was forced upon me long before my knowledge of economic and industrial subjects had matured, long before the company with which I have been associated since its inception had arrived at an earning capacity which justified the consideration of so great an expenditure for research.

My earliest and most primitive efforts when we were a small company were directed to encouraging every member of our staff to attend lectures and to travel. The funds of the company were always at the disposal of the man who wished to improve his mind or his experience. Useful as these methods were in our early days, with the extension of our manufacturing enterprises there grew a demand for knowledge which could not be thus easily satisfied. It is many years since I realised that nothing but a research laboratory, conceived on a liberal scale, manned by the best possible team, equipped in the most perfect manner and in touch with the seats of science and learning in this and other countries, could supply the needs of an ambitious industrial concern.

My service in the electrical industry dates back 42 years. At that time the industrial applications of electricity were confined to the telegraph and the submarine cable.

The telephone had just been invented, the incandescent lamp, the dynamo, the accumulator, even the electric bell, were scientific apparatus and had not then entered—though they were soon to enter—the field of industry. When I look back over this long period and ask myself by whom the big prizes in this promising industry were won, I find I can only answer "They were won by those concerns who, with prevision, had sunk money in research and development in countries which protected such enterprise by good patents and other sound economic legislation." And when I look at the progress of the countries of the world during the last 40 years, I find it is just those countries in which such research was encouraged and protected that have made the greatest progress and created the highest standard of living for their workers.

Speaking in the presence of so many Labour men, I will frankly admit it is true that, as a result, a great many monopolistic concerns developed, spreading their tentacles all over the world, and particularly influencing the industrial freedom of this country.

I have no complaint to make against monopolists so long as they realise that privileges and rights demand corresponding obligations and so long as they meet those obligations. I did, however, find fault with the fact that my own liberty of expansion was cramped. Those countries in which economic conditions favoured the prosecution of industrial research became a fruitful source of patents in the industry with which I am connected—patents in lamps, telephony, railway traction, switchgear, wireless, indeed in every branch. We in this country, where our system gave less encouragement to such research and development, became dependent on these foreign patents, and in their exploitation in our own country we were limited, and we were debarred by world agreements between the great industrial firms from many of the markets of the world.

When, therefore, as one of the lessons of the War—I felt it was my task to organise a powerful electrical concern in this country that in course of time should hold up its head against the giant concerns of other countries, I realised that money spent on factories, buildings, and trade enterprises alone would not be enough for me. I was convinced that the only chance of securing a position in the sun was to take a full share in the work of progress and development, which could only be done by the creation of such an institution as that which my company has established at Wembley.

In starting it I was under no illusion. I did not for a moment think that the engagement of a scientific staff, supplied with adequate resources in the form of experimental machinery and apparatus would enable me immediately to secure definite results. I realised there is little if any difference between industrial and scientific research. In both cases the foundation for progress is the acquisition of knowledge—of knowledge existing through the efforts of workers in the past, and knowledge that is being gathered every day by the efforts of the workers of the present. With able men, well versed in the knowledge already gained and placed in a position where they can keep pace with scientific progress, the second step can be taken—the application of knowledge for definite purposes, and that is industrial research. But these men alone cannot make industrial research successful; equally important, if not more so, is the preparation of the minds of those in our works and engaged on construction to receive and utilize such knowledge. One has to be large-minded in starting a research laboratory, and to realise that only by creating the right mental attitude throughout the whole organisation can there be

that free interchange between research worker and works staff, which will eventually lead to that greater efficiency which is the ultimate aim.

Our effort is too young to have achieved what we are aiming at, yet we have been in existence long enough to have obtained results from the study of specific questions which arise in our daily work, so that I am satisfied these research laboratories have more than justified their existence. They have done much towards the stabilisation of the quality of our raw materials and they have definitely solved problems with which we are concerned, to the great advantage of my company. By so doing, they have attracted the attention, the sympathy and even the envy of our powerful competitors abroad, which has lifted us on a higher plane and enabled us to claim the right to co-operate as an equal where before we should have been obliged to petition as a dependent.

They have, moreover, largely contributed to the knowledge of the country. You cannot make minute research on the problems of a vacuum, or on the chemical and physical characteristics of tungsten, without arriving at facts and knowledge which are of use to the whole community. The papers published from time to time by the members of our staff are looked for with interest by scientific and technical bodies. Research should not be undertaken on narrow and selfish or too mercenary lines if it is to succeed. But we are only at the beginning of things, and I am hopeful of much greater results.

It has occurred to me, however, to wonder why this question should be raised at a meeting of Labour, and I am reminded that those who lead and advise Labour have not always been sympathetic to science. They feel that new inventions frequently interfere with the established routine of organised labour. They see, unfortunately, only that by the invention of, say, the magneto, a few hundred, maybe a few thousand, people are deprived of their occupations, but they do not see the beneficial and broader effect on labour which such an invention may have. Consider for a moment how, through the magneto, the development of the oil engine was accelerated, how motor transport and air transport received an impetus which made up a hundredfold to Labour, in earning capacity and the comforts of life, for the little damage that its first introduction may have caused to a handful of men. Industry is peaceful warfare. As in war, very often a few men have to sacrifice themselves for the good of a whole army, so industrial progress creates, no doubt at times, inconvenience and suffering, but it is little compared to the benefits it bestows.

I have read too that Labour has criticised industrial progress as being merely a continuous effort to make more profit. No well-conducted big industrial concern works merely for profit. Profit, it is true, is a measure of success, but if you look at the dividends of industrial concerns (and distinguish them from trading concerns) throughout the country, you will find that those that have earned profit are constantly struggling not to part with more than is necessary to attract capital in the future for expansion. Any surplus over that is generally retained by the management for development, and if it has not in many instances yielded good results, it is in my opinion generally due to the fact that such development has been carried on by rule of thumb and not on a well-thought-out plan and by the organised methods of a research laboratory.

Any development, any expansion, is bound to create employment and must be for the benefit of Labour. One thing is certain, if all profit were given in a kind and appreciative way to workers, it would in the long run be an unkind act, because no funds would be available for development.

By the application of science the burden of labour is lightened. Who would exchange the post of an engineer on a modern Atlantic liner for that of a galley-slave chained to the oar of a Roman trireme? Or who would tramp daily many miles from his home to his place of work rather than travel by electric train or motor omnibus? It lifts labour to a higher level, it reduces the cost of production, and brings the commodities of life within the reach of many who could not otherwise afford them, thus creating a fresh demand for labour to produce them. By bringing machinery to the help of almost every operation, an opportunity is given to the worker not only to develop his muscles as in the past, but also to be in touch with the technical and scientific principles which control his operations. An intellectual interest is brought into his life which, in the past, has been denied to him in his work.

Do not you Labour men yourselves find that the least enlightened workers, the most difficult to organise, are those engaged in such pursuits as agriculture into which science has entered least? Another criticism once made to me by a member of the present Government was "Industrial research would not be needed if the Government would do its duty in the direction of research." I cannot agree with him. The Governments in recent years have tried to support research, but may I be permitted to say the means put at their disposal were so stinted that I doubted from the first the value of this experiment, and I am afraid I shall be proved

correct. But even if generous means were made available for Government research, where is the money to come from to apply the results of such research to industry, to make the experiments, to design and develop the plant ? Who, in the Government service, could be entrusted with the risk of having to admit failure, as so frequently occurs in industry after spending possibly hundreds of thousands of pounds as we have done. Research in dyes, in lamps, or railway electrification is in itself not expensive, but the expense comes with its application, and no Government could risk the many hundred thousand pounds that are wanted to convert a scientific discovery or invention into a sound industrial or economic proposition. It is only people who risk their all that create the will to conquer the difficulties which arise during the long and tedious progress, hoping to get their reward from a temporary monopoly such as is afforded by patents or sometimes by being the first to be successful in a particular field.

In my own organisation I could have found a dozen men at least who could have treated this subject in a thorough academic manner and given you a more reasoned exposition of the duties and the beauties of research in industry. As a man of business I thought the views I hold, looked at from a business point of view, might be more interesting because it is not often that the business man ventures on this subject. I may have treated it a little bit too much from the material side, yet I wish to assure you that the sentimental side has played not a minor part in my programme.

An organisation which employs 20,000 workers, with its factories and machinery and all the tools and implements required for production, seems to me a lifeless organism bound to become derelict or decayed during a period of depression unless it is supplied with its life-blood from one centre, namely knowledge.

PURE AND APPLIED SCIENCE

Sir OLIVER LODGE, D.Sc., F.R.S. : After Mr. Hirst's interesting speech, I feel inclined to switch from what I had intended to say and to rub in a few things that he has said. I will not take long about it. He has been speaking to employers of industry and telling them what his experience has been ; he could no doubt say a great deal more about that in detail, but we scientific men know what a tremendous lot the General Electric Company has done both in America and in England, although on a smaller scale in England and a very large scale in America, to apply pure science and to investigate pure science, in the faith that the results

will not only lead to Royal Society papers but will lead to real financial benefit.

Mr. Hirst has very wisely said, I think, that the employers of labour should not be actuated, and are not actuated, by considerations of profit alone. They are also actuated, like other men, by public spirit ; they are servants of the community ; they have great power in their hands ; they must feel its responsibility ; and if they see a way of doing good to the country surely they will be glad to do it. That is why they are honoured in their profession. As Ruskin used to say, what are the roots of honour ? We honour a surgeon or a physician because he is willing to sacrifice his life, to run risks, to do heroic things, when the call comes. He gets a fee, but the fee is not what he seeks. The fee comes in the course of events ; and so it is with all honourable careers open to men. The pecuniary reward is a thing that is added unto them. It is not for that that they work primarily. It comes incidentally ; it is welcome, and it helps further development. Even the little knowledge that I have of industries, through my sons, shows me that they are always putting capital into the business, not taking it out for their pockets or dissipating it, but using it for the purpose of developing their business, employing more people and turning out a larger output. Those are the things for which they can feel enthusiasm. That is the natural stimulus of their work ; and they aim also at improving the conditions of labour.

The interest of the worker should be kept in mind. By the best employers it is kept in mind ; for after all, what are we working for ?—the improvement of human life—and the workers are part of the living population of the country. We know how willing they are to volunteer in case of danger, to save each other from the accidents which may come in their way. They respond nobly when called on for rescue work in mining and in shipping, and for voluntary sacrifice in war. Human beings are not always quite reasonable. They may get misled by certain agitators, but they are sound at the core, and when the call comes they respond.

A study of the conditions of labour on scientific lines is being taken in hand. All that work of Dr. C. S. Myers is most valuable : the study, for instance, of conditions of fatigue. Some workmen think they are going to be speeded up, but that is not so. They are going to be under fairer conditions, and not be overstrained, and will have some elasticity and leisure thereafter for themselves.

Mr. Hirst spoke of pure science. I think he said that pure science by itself was not much use unless it was applied. I might

put it differently. We all hope that it is to be applied, of course. We agree really, but we have to work at pure science without any eye to application. We have not eyes at the back of our heads. We have to look forward and concentrate on the work in hand, and leave to others as a rule the applications. The applications will come, and we need not be afraid of that, but we do not put the applications first ; the applications are often taken up by others. Indeed, that is my theme. But experiment is necessary, and Mr. Hirst rightly said the Government cannot experiment. I do not think the Government can experiment, though really I do not know what a Government can do. But I find that if a Government is asked to support an experiment, it usually wants you to guarantee the result. You cannot guarantee the result. It is not an experiment if you can guarantee the result. So if private enterprise is willing to provide funds to have experiments made, then more power to its elbow. We must take a risk ; it is sometimes called gambling, not gambling in a bad sense, but taking a risk, acting in faith. That is the motive power of life ; and, depend upon it, in the long run it will be justified.

Now the importance of pure science to industry can hardly be over estimated. Every fundamental discovery involving real novelty is bound to take its origin in a study or laboratory devoted to pure science without any immediate regard to practical applications. When engaged in a novel investigation of any kind no one can have sufficient foresight to realise what applications may possibly follow ; and if too early attention is given to applications, ideas are switched from their proper direction, progress is impeded, and the result probably not attained.

After a discovery has been made there are any number of adaptations and alterations and improvements and developments, which are required from those who seek to apply it in practice. There is a great deal of difference between a laboratory experiment and an industrial output. The work of the organiser and manufacturer is by no means to be lightly esteemed. There are a great number of alterations, improvements and developments by those who seek to apply it in practice. These may be due to the original discoverer, but they are usually found to emanate from others, people who have a keener eye and more experience concerning a likely practical outcome. Something of the skill of the engineer is usually required, superadded to that of the physicist ; or something of the skill and experience of an agriculturist superadded to that of the biologist ; or the skill and experience of the surgeon or physician superadded to that of the bacteriologist.

The magnificent researches of Pasteur were begun entirely from the point of view of pure science; and it would have been impossible for anyone to foresee, in his right- and left-handed crystals of racemic acid and tartaric acid, anything of the tremendous practical outcome. At first the interest seemed purely optical. But the application, first to fermentation and then to disease, was made in an exceptional manner by the remarkable powers of Pasteur himself; though many physicians and other investigators took up the work, and the application to surgery was, as all the world knows, made by Lister, with later improvements introduced by Sir Almroth Wright and other laboratory investigators.

Again, the discoveries in heredity and cross-breeding, made by Mendel and others, received their practical outcome and application to agriculture through the practical schools at Cambridge and Rothamsted; and, except that I am being followed by Sir Daniel Hall, I would have tried to say something about the great and beneficent advances made by Biffen on wheat, but to continue that subject in Sir Daniel Hall's presence would be absurd.

Similarly, if I had not been preceded by Mr. Hirst, I should have called attention to the remarkable staff and equipment for purely scientific research which the wisdom of that great corporation endows and maintains, in a way which roused Sir J. J. Thomson's admiration during his visit to America, and which is also illustrated in this country too.

I will therefore confine myself to illustrating a few of the developments, some on a large, some on a smaller scale, of subjects which took their origin within my own memory, and with which I was rather closely connected; my object being to show how things began, with the object of showing how perfectly-pure science branched out into unexpected directions and with a magnitude which is quite surprising.

The discovery of electric waves, which now spread intelligence and human speech broadcast over the earth, took its rise in a mathematical investigation by Clerk-Maxwell more than half a century ago. The interest seemed purely scientific; in fact it aroused no public attention—that is not unusual; one would have difficulty in reading Maxwell's papers to-day—though they strongly excited the admiration and enthusiasm of a few students, of whom I was one. It took twenty years to bring these waves out of mathematical formulae into the realisation of fact; and they owe their production chiefly to the remarkable experimental researches of Hertz in pure science, when he was a young professor

at Carlsruhe. At first, in that case also, the interest seemed mainly optical and electrical. A few, like David Hughes and Sir William Crookes, and later, Alexander Muirhead, conceived their application to telegraphy. But it remained for the industry and skill and initiative and practical commonsense of Mr. Marconi to unify the various discoveries and really apply them on the large scale to the transmission of news.

The researches of Edison and Fleming and Richardson and others, which converted wireless telegraphy into wireless telephony, seemed at first to be concerned only with phenomena in vacuum tubes ; but nowadays these valves are in the hands of every wireless amateur—a surprising outcome in so short a time. Even the improvement introduced by tuning, which made selective telegraphy possible, was the outcome of mathematical studies by Lord Kelvin, so long ago as 1853, of the combined effect of inductance and capacity and of the Leyden jar oscillations which could be thereby produced. No one then thought of " wave-length " in connexion with such oscillations ; no one imagined that these oscillations would emit waves. That was reserved for FitzGerald at a later date, and to those, including myself, who followed up the hint which he gave. But even so, it was difficult to see how these waves could be detected, for we have no sense organ for their appreciation and no instruments known at that time were able to respond—although one gets letters from extra-sensitive people saying that their health is being ruined by the wireless waves.

Then take another case. The discoveries of Faraday were all made in the laboratory, and the first magneto-electric machine—forerunner of the dynamo—had a power and produced results utterly insignificant. So that indeed a member of the Royal Institution, after a demonstration by Faraday of a spark obtained from a magnet, asked what on earth was the use of it. And a dignitary of the Church is said to have regretted the discovery on the ground that it put a fresh weapon in the hands of the incendiaries, who were burning ricks about that time. But yet in that apparently small discovery (though it never seemed small to a physicist) lay the germ of all the dynamos and telephones and the great power transmissions of the present day, including electric railways.

To take a much smaller instance :—About the years 1883 and 1884 I began the investigation of the dark space above hot bodies, to which Tyndall had called attention. A red-hot poker or a spirit lamp held in the beam of a searchlight is seen to give off apparent clouds of smoke. You see black streams streaming in the illumin-

ated beam coming from this red-hot poker. It is not smoke, and Tyndall showed it was not really smoke, but it is a dust-free space. For some reason or other the dust is excluded from the hot air that arises from it. It is not burned up, though Tyndall thought so, but excluded for some rather obscure reason, and this free empty space you cannot see. When you see a sunbeam coming in through a window people say that you see the light by reason of the dust. The fact is you see the dust by reason of the light, and if the dust is not there there is nothing to see. You do not see light at all. You see the objects which emit it, and you certainly do not see light if it does not enter the eye. After Tyndall, Lord Rayleigh began to examine these dust-free spaces ; and the whole matter was subjected to a critical and careful examination for many months in my laboratory at Liverpool, using for the most part tobacco smoke in glazed boxes, with rods heated in a metrical manner and examined with a microscope. Incidentally the late Mr. Clark and I, who were working together, proceeded to electrify these rods to see what the effect would be ; and we found to our surprise that the whole box was cleared of smoke, very rapidly, and the whole space made dust-free. This curious observation was enlarged and exhibited in the autumn of 1884 to the British Association meeting at Montreal, at which both Lord Kelvin and Lord Rayleigh were present. It did not at the time seem likely to have any practical applications. But of late years Dr. Cottrell in America, and my sons in England, have applied high-tension electricity to the condensation, on a very large scale, of metallic fume and other smokes produced in smelting and furnace operations. Perhaps the largest scale operation is that to blast-furnace gases, which can be cleared of their potash-containing solid matter before they are either liberated or burnt. The same thing can be done in the smelting of tin and other ores, thus helping to save the fouling of the atmosphere and effecting a large economy in waste material.

So it happens constantly. The most unpromising subject—if only some definite result emerges—can be taken up and applied in ways quite unsuspected ; and I have been told that, in the laboratories of the General Electric Company, observations which at first seemed quite futile and merely curious, have turned out occasionally the most profitable of all.

It needs faith for those engaged in great industrial enterprises to divert a portion of their staff and equipment to investigations in pure science ; but everyone knows that in Germany this has been done, especially in the subject of chemistry, for a long time

and with great success : though unfortunately it has been possible —as it always is—to abuse these beneficent activities and prostitute them to unholy ends.

It remains for me to see if I can suggest any of the applications that might be made of the remarkable new researches into atomic constitution, which we owe to the purely scientific labours of J. J. Thomson, Rutherford, Bohr, and others ; and the other great development which has excited surprising popular interest, associated with the name of Einstein and the theory of Relativity. This is not the place to enter into detail ; but it is an undoubted fact that there are immense stores of energy locked up in the atoms of matter and in the ether of space, and it seems to me quite unlikely that fifty years will elapse before some of this energy is tapped and applied to practical purposes. Of course we are really using it, as we use all the forces of Nature, without knowing what we are doing, every day of our lives ; but it is not yet under control : we use it indirectly, therefore, mainly only in the form of sunshine, but also in combustion and chemical action generally. But there may be physical methods of getting at it too ; and the amount is so vast that if we could get at only one per cent. of it we should have a source of power which would put all others into the shade.

Whether the energy of the atom will be tapped first, or the energy of the ether, or whether we shall find that intrinsically they are one and the same in different forms, no one can say at present. But if I allow myself a Wells-like speculation, I can conceive the aeroplane and the steamship and the locomotive of the future as propelled rather like a rocket, by the reaction from a small quantity of material ejected from the tail at an immensely high speed, a speed far beyond that at which gases are expelled, even by the most powerful explosive. And I imagine that the propulsion will go on, quietly and without disturbance, because the ether is so massive a substance that, if we could find some mode of getting hold of it—as we already to some extent do in magnetism—masses of ordinary matter could be propelled with great ease, at a speed beyond anything as yet attained. This may seem rash speculation, but I take this opportunity of putting it on record, because there is a great deal more to be said about it, in the proper time and place, and because if it is ever achieved it will be the result of some of the most unpractical and weird and ultra-microscopic investigations which have ever roused the curiosity and ingenuity and puzzled enthusiasm of man.

SCIENTIFIC RESEARCH IN AGRICULTURE.

Sir DANIEL HALL, K.C.B., LL.D., F.R.S. : It is my business to speak this afternoon about the one industry that our first speaker described as an industry to which science had not yet been applied—the industry of agriculture. Well, I am not quite prepared to admit that ; but I am bound to say that agriculture, the most fundamental of all industries because we have all got to be fed, is the industry which at the present time is most suffering from the enormous development and scientific achievements which have distinguished other industries. I say that advisedly and most solemnly ; because you cannot turn to any part of the world where agricultural produce is being turned out and find farmers in a flourishing condition. Their labourers are being drawn away by the superior attractions of the towns ; the men themselves who farm are diverting their capital and their energy to commerce. The man-power in the industry is being drawn away by the greater rewards which the more organised industries offer ; and so, as I say, in all countries agricultural production is at the present time suffering as a consequence, an unfortunate and indirect consequence, of the many scientific developments of the other great industries, and the immense pace at which they have grown.

This cannot go on for ever, simply because the business of producing food is fundamental. Also the business of producing men is one that we in agriculture rather pride ourselves upon—that the countryside produces a valuable stock for the maintenance and the well-being of the community.

As I say, the shift from the country to the town cannot go on for ever. If the attraction proceeds very much further, then a limitation will fall upon the development of the towns simply because there will not be food to go round.

I am not going to admit that scientific development has not taken place and is not taking place with regard to agriculture. A very little consideration of the history of agriculture will satisfy us that considerable developments have taken place, and are likely to continue. If we go back, say, to mediaeval times, we shall find that the yield from the land of corn was then in the neighbourhood of six to eight bushels to the acre, and that advanced by improvements in the process of cultivation, by introducing the fertilising clover crop, and so forth, until the amount had risen to a level of about twenty bushels to the acre. This may be taken as the level achieved when agricultural science dawned in this country—say, about 1835 to 1840, which was the time when Lawes began his experiments at Rothamsted. There followed half

a century of considerable development, because two things coincided. There was a scientific development—the study of nutrition of the plant such as was carried on at Rothamsted; and at the same time commerce and industry placed at the disposal of the farmer fertilising materials like sulphate of ammonia, nitrate of soda, bone and mineral phosphates and later basic slag and the potash deposits, whose value was revealed by these experiments. The artificial fertilisers were developed in that half-century from 1830 onwards; and we find as a consequence of this addition of fertilising material that the average fertility of British land was raised by at least 50 per cent., and that by, say, 1880 or 1885, the average production instead of being 20 bushels to the acre had become about 32 bushels to the acre. The limitation of the increase of fertility in this direction has not yet by any means been reached. Actually you find that from the eighties down to the present day there has been no increase in the average yield from our land, although even greater amounts of fertilisers have been at our disposal; simply because there has been an economic factor at work, the opening up of new countries, which caused the production of heavy crops to be less remunerative than a more extensive cheap production of comparatively light crops. There has not been the amount of pay, as it were, attached to intensive production that would justify it; so that continued increase in the yields per acre due to fertilisers has been limited by the economic factor.

Now in other directions—as, for example, the feeding of animals, —we have had a great development of theory which is leading not so much to greater production as to more economic production; and that, from the point of view of the person who is going to consume, is after all the more important. The waste of feeding stuffs, in the ordinary rule-of-thumb feeding of animals, is enormous. During the war time, in those dangerous years 1917 and 1918, when all our shipping was required for the purposes of conveying munitions of war and when we could not spare any tonnage space for cattle food, we had occasion to make a calculation of how much cattle food had been consumed by our herds and flocks in the years preceding the war. Now from the scientific studies that have been made on feeding we arrive at certain conversion factors. So much food of certain classes would be needed to produce a gallon of milk, or a pound of meat, or a pound of pork, or a pound of eggs, and so on. When one came to study the amount of food that had to be consumed, in order to produce the amount of meat, milk and similar animal products which had been turned out in the United Kingdom

in the years preceding the war, one found that there had been a wastage factor of something like three to one ; that is to say, we had not attained more than one-third of the theoretical output of meat and milk that ought to have been derived from the amount of cattle food that had been consumed.

Now, there is no part of our subject that the farmer is more jealous of than his acquired knowledge in the art of handling cattle and feeding them. Still, the research that has been carried on is filtering down, and very great economies are being effected upon our farms in this utilization of feeding stuffs which in turn tends to the cheapening of the product like meat and milk, and that in its turn acts on the amount which is available for the consumer at the rate of wages that he is receiving.

Then take again the question to which Sir Oliver Lodge alluded—the production of improved varieties of farm crops on the lines opened up by Mendel. There is a great opening for science and great possibilities in arriving at control over Nature. Mind you, there had been unorganised work before, and it is the pride of British agriculture to have effected great improvements in the primitive cattle, the primitive sheep and the primitive wheats for all the world. The new countries are peopled with animals derived from our flocks and herds. Our breeds are the great colonisers of the world. A great deal of unorganised work had been done ; but for twenty or twenty-five years organised work has been possible in consequence of the testing out of the Mendelian hypothesis, and the way that Bateson drove its potentialities home to the consciousness of a little school of enthusiasts at Cambridge. Professor Biffen, his pupil, has produced a number of new varieties of wheat. It takes time to produce them and to get them distributed, but they have now got a very widespread distribution all over the arable districts of this country, and already we can begin to see, even men sitting in the Ministry of Agriculture compiling statistics, the effect of Biffen's wheats upon the average wheat yield that is being turned out by Norfolk and Suffolk and those great grain-growing districts. We are only at the beginning of the improvements that can be effected. They are improvements which are the more valuable in that they are brought about without any increase in the cost of production. It does not cost any more to grow a wheat which will yield, say, 45 bushels to the acre, than another wheat which, under similar conditions, will only give us 40 bushels ; and increases in the order of 10 per cent., or even more than that, are easily realisable and are in sight.

I perhaps need not say more about that point ; but again there is the enormous field for research in the cheapening of production upon the farm by eliminating disease. At the moment, the country is engaged in paying a bill which I believe amounts to about three and a half millions to-day for the ravages of foot-and-mouth disease during the last year ; and that bill represents perhaps only one portion of the loss which the community has suffered, because we are only paying to the farmer compensation for the actual cattle that have been slaughtered. There is no compensation—nothing included in that three-and-a-half-millions bill—for the loss of production during the period in which the farm was shut up and all the collateral losses which have fallen upon the farmer. Now I do not say that we are going to clear out disease ; but at any rate we have plenty of examples of the way in which the effect of disease can be minimised, if we set to work and investigate and get a clearer idea of the causes leading up to the disease. Great progress has been made in many directions, but this particular field has not yet successfully been broken into. These are the fields which lie before us for agricultural research, and where a great deal of work is now on foot.

But notwithstanding all these possibilities—and they are great—we must recognise with regard to the application of science to agriculture that there are limitations which do not apply to the other industries, and they are enormous limitations. In the first place, in agriculture we are dealing with a living organism, and whether it is a plant or the animal, the amount of control that we have obtained over inanimate nature, over iron or steel, or even over ether or the atom, is far greater than the amount of control we have obtained over that stubborn essence that we call life. We find as soon as we attack vital problems that we cannot speed up processes in the way that we can speed up the dynamo, or accelerate a cotton-spinning machine. It still takes the wheat plant six or nine months to develop. We have not yet succeeded, and we see no possible way of succeeding, in growing two, three, or four crops a year under our climatic conditions. The organism that we are dealing with will go through its cycle, and you cannot hurry it at all. If you do hurry it, you find very often that it is an uncommonly uneconomic process, because it lets in all kinds of other secondary trouble. That is one of the limitations that agriculture is subject to, and one which lies in the nature of things. Therefore, as I say, although on looking back we may see immense advances which have been made by the application of science to agriculture, we must not hope for sudden revolutions or any of

the sort of great changes that have been taking place during the last thirty years, as in the marvellous stories of ether waves which Sir Oliver Lodge has unfolded to you.

Then, again, let me turn to another side. Just as we are dependent in agriculture upon applying our science to a living organism, we are perhaps even more dependent still for our output upon the human being who creates output. As I say, we have got to pin our hope to science, and to development, and for more than one reason. At the present time I would say that agricultural workers are the step-children of industry. They have the lowest rate of wages paid to them. They are the men of the labouring class most cut off from all what you might call the amenities of modern life ; and that process is being accelerated. None the less, if you were to try to build up a great business like the General Electric Company to deal with the land, and to apply wholesale organisation, machinery, and all the developments of knowledge, you are very likely to find yourself going wrong. Joint-stock companies never have yet succeeded in dealing with agriculture. There are very few cases indeed of large-scale capitalist farming succeeding. In fact, although as I say, I pin my faith on that large-scale business as necessary to the world if we are to get great organised production to meet the growth of cities, none the less I am bound to say I see the current swinging in the other direction. The businesses which employ labour are getting less remunerative, and agriculture is more and more drifting into one-man businesses all the world over. In this respect we stand as a country, almost alone, not quite alone, but still what you may call the capitalist development of agriculture is far more manifest in England and Scotland that it is in any other country of the world. It is, perhaps, an imperfect capitalisation— small businesses employing anything from six to twenty men, but still when it grew up it did represent a great development in organisation.

Now the current at the present time is running against those businesses. There is a level of prices that is driving those businesses out of existence and is throwing agriculture back to the one-man farm and the small holding. Everywhere the desire of the individual for independence and for having a bit of his own, the determination to call no man master, draw men into agricultural production and induce them to work for 10, 12, or 14 hours a day, at a pace which they would never give to any master or to any joint-stock company. We have as I say a social current running against the scientific development of agriculture, and the only hope for large-scale organized production is that the gain which science can make

shall be so great that big organized business can be enabled to compete with the excessive labour of the one-man farm, wherever it may be situated in the world. Only by science can the big organised farm succeed while paying the men wages and giving them conditions of life equal to those of other industries.

I therefore, if I may say so, pin my faith upon science, and I have daily to consider in my official capacity the application of research to agriculture. Well, here we are not dealing with private capitalists and with the private enterprise that can subsidise research in the style that our first speaker spoke of. Whatever opinions we may hold about the relative advantages of the research promoted by the Government, and research in the hands of individuals, we have no alternative when we come to deal with agriculture. The man who is farming 100 acres is in no position to subsidise a research station, and therefore the organisation must proceed from the Government. To that end we must ask ourselves how we can move faster—how we are most likely to draw out the fertilising research that we need ; and I think, if we are going to do that, we must study a little the psychology of the research worker, how he goes to work and why he goes to work. I differ in part from some of the remarks made this afternoon, because I regard the research worker especially as a man who does his job out of a response to the natural curiosity of a man's mind. Man is curious to know, and the real research worker can no more help trying to discover things than can another man help devoting himself to poetry or philosophy or the painting of pictures. Such men cannot be turned away from their purpose ; it is their one outlook on life, and they will go for it if they can get the chance, whether it pays them or does not pay them.

I repeat that real fundamental discovery, originating scientific research, works by a mental process which is more akin to that of the arts than the systematic logical processes which we usually associate with science. In fact, if I had time I should rather like to develop the thesis, that many of our most eminent scientific discoverers have been fundamentally unscientific people with no logical mind, and none of the qualities of system, order, deduction and induction, which we commonly associate with science.

However, there is not time for that ; and I will only try to insist that the intellectual process by which scientific discovery proceeds is one of intuition—that power of looking round the corner, and of seeing something which is not there. Well, if that is the case, I think it follows that we can no more organize research into being than we can organize the output of poetry ; and what I

conceive to be my function as the head of the scientific service of the State in connexion with agricultural research, is that I must somehow create sheltered places in which the right kind of man can find a place in which he can live and expand and blossom. Those sheltered places are not to be found in Government offices, but more probably in the universities and kindred institutions. But if we are to get our output of knowledge, our fertilising new discoveries, we have got to create those sheltered spots and have faith that sooner or later the right man will grow in them.

INDUSTRIAL RESEARCH

Mr. A. P. M. FLEMING, C.B.E., M.Sc. (Director of Research and Education, Metropolitan Vickers Electrical Co., Manchester) : The objects of this Conference, in endeavouring to identify the interests of labour and science, are most laudable. I have listened to the eloquence of the preceding speakers with great admiration, intense interest and apprehension, because I have seen the dwindling possibilities of being able to add any further remarks by way of argument on the subject.

I am going to confine myself then to a few remarks on the question of the interpretation of industrial research, because there is much misconception about this, especially on the part of Labour. I would plead for the widest possible application and interpretation of this term. Just as industry, in its fundamental sense, is merely the transformation of some raw material, some resource of Nature, into a form in which mankind can use it, so industrial research, in its widest application, is simply the means of making that transformation as efficient as possible. Sir Daniel Hall has given us agriculture as an example, and to take one other example, we are all familiar with the transformation of iron ore into iron and steel, in the very varied forms in which people use it. There are a whole chain of links in this one transformation process ; and if we look at these individual links, we find there is room for increased efficiency in the making of the raw materials and for improvement in the making of articles from them, by the better application and training of Labour, and by the cheaper, more effective production and application of power. In fact, as we look at this transformation process we call industry, we find that industrial research applies itself definitely along certain lines. First of all we have it applied to giving us better knowledge of the materials we use and to giving us better material. Mr. Hirst has spoken of the electrical industry, an industry which has grown to huge proportions within a matter of less than a century ; and

yet an electrical engineer, dependent as he is on magnetic materials, is abysmally ignorant of the fundamental reason why the material is magnetic. He knows little or nothing about why the material does or does not conduct electricity ; and the groping for new materials of this kind is almost a blind grope ; so that until we have more fundamental knowledge in this respect we cannot look for a very vast improvement in our materials. There is a great field there.

Then there is the question of improving our industrial processes. Every day, as Mr. Hirst pointed out, we are getting increased experience from the workers ; we are getting improved techniques and additional technical knowledge which can be applied in the improvement of our industrial processes. There again is a big field, and in that respect our transformation process can be made more efficient than it is.

Then we have another field, a most important one—the human field. That point has been touched upon by Sir Oliver Lodge in referring to the work of Dr. Myers and others, in endeavouring first of all to get at the sound scientific basis for the selection of workers, to prevent a young worker from being allowed to get into a channel which to him is virtually a blind alley, and where eventually he finds he is not working according to the particular bent with which Nature has endowed him. In that respect the principle of round pegs in square holes represents an appreciable loss to the community. Then we have the other aspect, the endeavour to make work less arduous and more pleasurable and satisfying. This is increased efficiency which the physiologist and the sociologist are endeavouring to attain, and which is of the first importance from the point of view of scientific research.

We speculate, and we have had some speculations this afternoon, as to the possibilities of the times or the possibilities of the future as the case may be. We have to look for cheap power and cheap energy, not only for the purposes of transformation but for every phase of industry. In fact, in every phase of human life we need it. We need it increasingly in our homes, and in every way there is room for considerable improvement and the cheapening of supplies of energy ; and while we may speculate scientifically as to new sources of energy, there is still much to be done in the development of improved means along the present old-fashioned lines of burning coal under a boiler, raising steam, and then at last deriving electrical energy. It is wasteful, we know ; and possibly somebody sometime will give us electrical energy from coal direct with a 99-per-cent. efficiency. There is plenty of room for progress

and there is in that particular link need for increased efficiency. But the greatest of all possibilities lies along the lines touched upon by Sir Oliver Lodge in the application to industry of the fruits of pure science. In Mr. Hugo Hirst we have the industrialist of the highest type. He disclaims very modestly any great knowledge of science. I think he knows probably a great deal more about it than he has admitted to us. We have on the other hand Sir Oliver Lodge, a physicist of world repute, who disclaims any knowledge of industry. He again does this very modestly, and I think with his tongue in his cheek. We must not take these two notable examples and base on them a general rule, because, generally speaking, the industrialist does know very little about science, and the pure scientist very little about industry, and it is that gap which needs bridging, for it is a gap which represents at the present moment an incalculable loss to industry.

We have heard many examples quoted—and I do not intend to add to them—of the fruits of pure science as they appear in industry. But we have to remember that that event represents a very great time-lag, and industrialists of the more progressive kind, such as those represented by the great laboratories which have been spoken of, are endeavouring in their own way to bridge the gap. But it is being bridged very imperfectly, and until we have a new type of technical industrialist—what I would call an industrial physicist type—grow up, I think the gap will not be completely bridged. I would particularly make a plea to those who in the university train the younger physicists, that they should direct some attention to the possibilities open to young men with a sound fundamental knowledge of physics, and who also have industrial experience—men who are informed and are able to follow the advances in pure science—and those advances are very rapid and very great—and who have had industrial training and a knowledge of the evolution in industry. The knowledge and experience such men possess would not only enable them to meet the practical needs of the present, but also to evaluate the industrial possibilities of new discoveries.

DISCUSSION

Professor E. C. WILLIAMS, M.Sc. (University College, London) : We have listened to an extremely able series of addresses on the application of science to industry, but I have noticed that in all the speeches this afternoon science has been interpreted mainly as denoting the scientific discoveries of what may be called the

philosophic scientist, working for the pursuit of knowledge alone, without any eye towards industrial application. No one will question that many epoch-making advances in industry have been made by the application of such discoveries, but what this Conference is called to debate is not so much whether pure scientific discovery is valuable from the industrial point of view—that, in the light of history, needs no debate—but rather how such discoveries are to be applied in industry. On that point less has been said. It has been said that if only the pursuit of knowledge were followed by the scientist, others would come along and apply it. The case is not quite so simple as that. It requires no less scientifically-minded and trained a man to visualise the germ of industrial usefulness in a new discovery and to develop, modify and design the means for putting that discovery into active industrial operation. It is the mechanism of application which is most in need of speeding up, and the employment in that mechanism of the highest type of scientific mind.

For the discovery of fundamental truth undoubtedly the university atmosphere is the most productive, and the best method for developing it lies in the adequate endowment of the university schools of research. The General Electric Company have realised that and in their own interests have created what is, in effect, a university laboratory and a university atmosphere within their own organisation, in a way which must be the admiration of all who follow industrial development. Very few firms can afford to do this, and those who have done it may be counted on the fingers of one hand. There must be something more, however, than a centre of fundamental research, active work on the development of such researches must be continuously in progress. When a new discovery of process or product leaves the hands of the research chemist or physicist, it is, quite apart from economic considerations, by no means a workable industrial proposition. It may contain the germ of an industrial process but even that may not be evident. The research worker, perhaps by reason of his own particular abilities or temperament, may not be the man to see the possibilities, much less to develop them. The actual development work is nevertheless essential and calls for work equally imaginative, scientific, and difficult of achievement as that involved in the initial discovery.

Frequently, promising but immature scientific discoveries pass too rapidly into the hands of the engineer or a dividend-seeking management who may push on plans for works development before the occasion is ripe. This may not always mean failure, but usually

does mean an expensive and wasteful period of empirical experiment and makeshift on the large scale, much of which might have been avoided by proper investigation during the development and design stage. It is this *liaison* between the research laboratory and the works which we in this country most lack and to the presence of which, rather than to any superior inventive capacity, is due the fact that certain of the German industries are ahead of our own. There is, as Dr. Fleming has expressed it, too great a lag between the initial discovery and the appearance of the industrial counterpart as an efficient working process. It is to the elimination of this lag that we should direct our efforts. I believe that as rapid, possibly more rapid, industrial progress will be made by training men specifically for the scientific development of known chemical reactions from the laboratory to the manufacturing scale, and for the application of scientific methods in the design of the plant required to operate such processes efficiently, as will be made by the application of science to industry in any other way.

Fundamental research into new products and improved processes must, of course, continue, but it is a slow process to institute research for the purpose of discovering facts which will be of value in a definite foreseen direction. The tendency is indeed more and more for industrial research workers to explore a far wider domain than is apparently involved in the problem immediately ahead; that is a reversion to the view that the most valuable industrial developments often result from the pursuit of knowledge alone.

A large field for the more direct application of science to industry, therefore, still remains open and yields ample opportunity for fundamental researches of another type along the border-lines between physical chemistry, physics, and engineering. At present this field is something of a no-man's (or everyman's) land. Let us consider what type of scientist is particularly required for work in this field and consider especially the needs of the chemical industry. In the first place, as he will need to keep in touch with the work of the research chemist and appreciate what is likely to be capable of industrial development, he must be a thoroughly trained chemist, but he must look at the problems with which he deals from a point of view very different from that of the average research chemist.

It does not at all follow that because a process can be carried out smoothly and expeditiously in the laboratory, it can be carried out either smoothly or expeditiously or economically

on a large scale. New factors assume an overwhelming importance as the scale of operation is increased. Energy changes accompanying reaction or change of state, the speed with which heat can be supplied or withdrawn from reacting masses, the temperature conditions dependent thereon, the equilibria in simple and complex systems, and the speed with which such equilibria can be attained (particularly when this involves the transference of materials across phase boundaries), the possibility of increasing these speeds either by design of plant, the use of catalysts or the increase of the degree of dispersion or agitation of the reacting substances; the influence of the reactants or products on the materials of which the plant is constructed; the mechanical and structural efficiency of the plant in which operations are to be conducted; and lastly and most important the economic factors which govern all commercial working. Few of these factors will have been considered when a new process leaves the research laboratory.

I need not labour the point that here is an enormous field for the direct application of science and scientific method to industry, and it is evident that in addition to being a chemist, and particularly a physical chemist, the man who will work in it must further be sufficiently acquainted with the underlying principles of mechanical and structural engineering to enable him to put forward well-considered calculations and drawings for the use of the structural engineer who will ordinarily be called upon to build the works or plant. I do not think we can expect him to be, in addition, a fully-trained and practised engineer in the usual sense; what is most needed is that the essential facts and quantitative calculations which affect plant design should be worked out scientifically, and the layout of the plant itself brought to such a point that the question is one of pure engineering construction; from that point onwards we are already in a very strong position.

It is along these lines, I submit, that we must look for one of the most direct and profitable applications of science to industry; the men will be those who, as Mr. Hirst says "come along and apply the discoveries." It does not matter what we call them; the department I represent, which is designed to meet the increasing demand for men trained along the lines indicated, is called a department of chemical engineering (it might equally be a department of physical engineering—the name does not matter), but whatever we call them, we believe the type of man to be urgently needed in our chemical industries to-day and that, by concentrating on the production of such men, we shall benefit the industries con-

cerned and find a splendid outlet for the trained scientific skill of a number of our university graduates.

Major A. G. Church, M.P., Mr. J. W. Williamson, B.Sc., Mr. E. D. Wedmore, Dr. R. S. Hutton, Mr. J. G. Pearce, B.Sc., and Mr. Clifford C. Patterson also contributed to the discussion.

CHAPTER III

CO-OPERATION OF SCIENCE AND LABOUR IN PRODUCTION

The addresses printed in this chapter were given at the Third Session of the Conference on Science and Labour held at the British Empire Exhibition, Wembley, on the 30th May, 1924, Mr. C. T. Cramp in the Chair.

Mr. C. T. CRAMP: This is the third of a series of meetings held under the combined auspices of the British Science Guild and representatives of organised Labour; and I want to say right away that when the British Science Guild put forward its proposals for some co-operation as between organised Labour and itself, I was delighted, because it seems to me that there has been not exactly a conflict, but there has been a neglect by both bodies of the aspirations, the thoughts and the activities of the other. So far as the workers are concerned, I doubt if they have thought in a general way about science at all until comparatively recently. I remember that some years ago in a little village institute, of which I was a member, someone proposed that we might endeavour to study science, and one of the members at once said: "That is right; we will buy some boxing gloves." We have at any rate advanced in our conceptions of science since that time; but I wonder whether either side comprehends the needs and the outlook of the other side even at the present time. I hope I am not saying too much when I would describe men of science, absorbed as they are in the pursuit of truth to the exclusion of emotional interjections, when I say although they may not be inhuman, they perhaps tend to become a little non-human. At any rate, that is the way in which Labour has looked at those who pursue scientific pursuits. On the other side, I am afraid that men of science will have grown a little impatient of what they will regard as the waste which is involved in industrial conflicts which do take place from time to time; and it is quite a good thing if we can get each side interested in the interests and activities of the other side.

Labour in the past has, I fear, had reason to regard every labour-saving device as a wages-saving device. On the other hand, Labour has been too much content to leave the application of science to those who have been perhaps better constituted with regard to its appreciation and its use. But now the move has been made, and I have to say the shadow of a move came first from the men of science. I hope it is going to develop until Labour

understands that science should be the servant of the community and not its master, and that wisely used and applied it ought to assist Labour and it ought to assist the community ; and that science, on the other hand, will understand that the human factor must be considered when the results of science are applied to production.

MAN AND MACHINE IN INDUSTRY.

Rt. Hon. Lord ASHFIELD : My subject is Labour and Science in Production. If the fundamental question is stated plainly, can there be any discussion at all that work should be carried out as efficiently as possible, and with the least expenditure of human energy ? It may be I should introduce one qualification. The work to which reference is made is the work which we *must* perform ; the work by which we earn (as is said) our living. If the work were the occupation of our leisure hours—and upon that I shall have something more to say—if it were pastime, there would be a difference, for our whole attitude or point of view would have shifted. What then can I say to open up the matter to you ?

I am tempted to go to one of my own companies for an illustration and a lesson. The London General Omnibus Company started with horsed omnibuses, and kept them in yards and stables scattered about London. At one time there were as many as 1,400 vehicles and 17,000 horses engaged in its services. It was not a scientific business. It was an enlarged and expanded job-master's business but, so far as its facilities were allowed, it rendered a great service to London. But as time went on, the transport of an ever-increasing population demanded something more efficient, and in 1904 the first motor omnibus appeared, and the two-horse vehicle met the 20-horse-power vehicle (you will notice how different is the measure) in deadly rivalry. Yet the two-horse vehicle was the only reliable vehicle for many years, and the London General Omnibus Company did not rush after the novelty of the motor omnibus. Then in 1910 the transition came. Horses speedily disappeared, and with them the men who were unable to keep pace with the changed conditions. There was some hardship, although the transition was spread out over a period of two years. But the result was highly beneficial to Labour. The horse bus could not travel very far. The horses grew tired. The longest routes were only just as long as a pair of horses could jog or trot from one end to the other and back without undue strain or effort. The motor-bus could accomplish much more without

a rest; and so with the new vehicle came first the possibility, rapidly followed by the realisation, of the wider area which could be covered, and the outer suburbs first enjoyed their services and the country excursion trips began, and with all this the number of omnibuses went up and doubled itself, and so doubled also the total employment.

All this, while the repair and upkeep of the vehicles was taking place at shops attached to garages scattered over London, following the practice of the old horse-stable days. Each garage was complete in itself with shops, stores, machinery and equipment for looking after whatever were needed by its hundred or more omnibuses. When the experimental period of the motor-bus was passed, and it was possible to determine which type of vehicle was the most efficient that could be invented or constructed within the limits laid down by the police regulations, all the vehicles were replaced by those of a standard type and varied only in minor details. Every garage, therefore, wanted the same plant, tools and supplies. This position was reached about the year 1914. Then the War came, bringing a severe pressure upon transport undertakings, especially those employing road transport vehicles, for road transport vehicles with their skilled drivers, fitters and repair men were most urgently needed behind the battle fronts.

The Company can be proud of its record, for it sent some 1,500 omnibuses and 10,000 men to the war, organized and equipped, for the most part, out of the Company's resources at a few days' notice. It learnt from this trial. It learnt how to economise resources and labour; it learnt how wasteful it was to continue some 30 independent shops for the upkeep of these vehicles, instead of one central repair factory. After the War, therefore, the engineers of the Company were set to devise the best central factory possible. They were sent to works in this and in other countries to study methods and machinery. In the end the Chiswick Overhaul Works were built. They were opened in June, 1921, and on that date the Company owned or operated 2,860 motor omnibuses and employed about 5,520 men in repairing, cleaning, inspecting and maintaining them fit for the road. Another problem which was dealt with at the same time was the cleaning of omnibuses. Each bus must be washed and put into a tidy condition before going into service each day. The work was done by hand and required a very large staff. Washing machines were installed at the garages, and each bus passed through the machine as it entered the garage after completing its day's work. These

improvements increased the output capacity of each employee and resulted in the dismissal of a large number of workpeople. The second result was a very considerable saving in the cost of maintaining and cleaning the omnibuses. The third result was the enlargement of the margin between earnings and expenses. The fourth result was the expansion of the fleet to almost 3,750 vehicles, so that, whereas in 1920 18,000 men were employed, in 1924 24,000 men are now employed. So one result led to another result, and in the end Labour was directly advantaged. In each grade of service more men were ultimately engaged. A further result was that higher rates of wages were made possible because each man was producing more.

This series of results was mainly achieved by the pursuit of scientific principles in the layout, design and management of the works. The omnibuses were, as I have said, standardized. The problem was, therefore, to deal with the repetition of a process with dispatch and exactness. Special machines were devised to carry out special tasks. For instance, a machine was installed for doing a particular job, and this machine, with four men in charge, performed in twenty minutes what previously it had taken a man working alone two days to do. Careful methods were thought out for the most complicated jobs, and a series of men specialized each to do their part ; for instance, for the overhaul of an engine the time was reduced from 85 hours to 29 hours. One simple rule borrowed from the Ford factory in America was, to bring the work to the man instead of taking the man to the work. Moving belts and conveyors were established in lines throughout the factory down which the various components of the omnibus chassis were carried and passed from man to man, the ultimate achievement being that whereas under the old system an omnibus was out of service 16 days for its annual overhaul, it is now out of service only four days, with the effect of automatically increasing the daily working fleet by 100 omnibuses without any increase in the capital invested. These 100 omnibuses afforded employment in themselves for about 500 men on the operating side—almost the same number of men as were dispensed with on the engineering side by the opening of the works.

But here I must pause, for you will realize at once that the 500 men engaged were not the same persons as the 500 men discharged. There is the crux of the problem—the readjustment of labour when the work changes in character. In this instance the difficulty was speedily met by the expansion of the omnibus fleet in

numbers ; but this might not have been the case, and so I reach a real problem. While there can be no question that the adoption of the most scientific and skilful means of executing work must be beneficial, it does not follow that the new benefits are or can be immediately distributed over the old workers.

The classical example to which economists always seem to resort is the textile industry. When the power loom superseded the hand loom at the beginning of the nineteenth century, during the fifteen years of transition the number of looms remained almost exactly the same ; but while the hand looms had employed 225,000 people, the power looms only employed 150,000 people. In the next fifteen years the power looms almost doubled in numbers and became equipped with automatic devices which helped to make them independent of attendants, so that, for all the doubled number of looms, the people employed were only 200,000 and were therefore still less than those who were employed in the hand-loom days. It took fifty years for employment to reach the same level by the expansion of work. This was a tragedy for the worker, a tragedy in its most true sense, for the consequences were inescapable. They were indeed aggravated at the time by needless and shameful abuses, now happily beyond repetition—the abuses of excessive hours, of child labour, of sweated conditions.

But let us look at the other side of the picture. At the close of the hand-loom period the goods produced were about 143 million pounds weight in the year, of which 83 million pounds were exported. The labour cost was 9d. per pound. Fifteen years later again the output was 348 million pounds weight in the year, and the exports nearly trebled to 228 million pounds. The labour cost was then 3½d. per pound. Fifteen years later again the output had risen to 651 million pounds weight, or almost five times, and the exports to 536 million pounds, or almost seven times. The labour cost was then under 3d. per pound, although all this while wages were steadily rising and the hours of labour were appreciably shortening.

With the aid of a dramatist we are able to bring to life again both the contrasted grievousness and hopefulness which marked this critical phase of industrial history. In "The Machine Wreckers," by Ernst Toller, we see the protagonists of the change in the ranks of Labour itself. We see the weaver whose slowly-acquired skill is suddenly not wanted, for whom the machine means unemployment, for whom the machine represents a loss of

craftsmanship, for whom the machine means nothing but servitude. He speaks :—

> " This devil Steam
> Clutches you in a vice and tears
> The heart from out the breast.
> And then he saws, and saws, and saws
> The living body into pieces.
> Charles, you shall be the foot, to tread,
> To tread, to tread your life away . . .
> With slackened arms and clouded eyes
> And back bent crooked at the mill.
> George, you shall be the hand to tie
> And knot and fasten, knot and tie,
> With deafen'd ears and creeping blood
> And dry rot in the brain. . . ."

He sees the specialization which reduces humanity to a mere adjunct to the machine.

Then on the other side we see the engineer, the man in charge of the machine, who realises the potential energy hidden away in it and the beneficial results which will spring from the deliverance of the workers from the extreme rigours of toil, who sees in the machine the conquest of the material world with the vast developments which we now know the machine has created. He sees the skill that will be demanded of Labour under the new conditions, the advance towards a higher stage of labour. He too speaks :—

> " You trod the looms like galley-slaves, with limbs
> Bent crooked by the load of drudgery.
> The engine's your salvation ! Even now
> The boiler quivers on the glowing coals,
> Pregnant with steam ! One touch is all it needs !
> The engine quickens ! Energy is born !
> The fly-wheels waken, stretch themselves,
> Whirl in a humming melody !
> The sliding pulleys try their belts.
> One touch ! the frame of yarn is warp'd,
> Another, and the weft is thrown !
> No felting now with weary hands.
> The shuttles fly to work, and set
> The bobbins reeling fast. One touch,
> The engine's tamed. It comes to rest."

It is perhaps the hardest thing of all to see both sides of a problem in which one is personally involved. At this distance of time it is, of course, easy for us to see it, and that is one of the great values of history. It teaches us to reserve our judgment, and not to stress our personal point of view in current controversies.

We can see now that the machine in all its manifestations was a wonderful contribution of science to industry, and the reward of industry was the enormous expansion of its markets for the cheapened products. So it always is, the ultimate testimony to the fact being the population of these islands of ours, the heart and core of this Empire. For centuries the population was almost stationary at about five or six millions. Then the industrial revolution came of which I have given you one or two glimpses; and decade by decade the population grew, from six to seven to eight to nine to ten millions, from ten millions to twenty, from twenty to thirty, from thirty to forty, and we present to the world to-day the spectacle of a nation not self-supporting, yet masters of, because servants to, a quarter of the habitable world. I will not be tempted to moralize over this spectacle, to allot praise or censure; I will leave it as a fact, for as a fact it speaks for itself.

So far it is clear that the development of the technique of industry has been nothing but advantageous in the long run. Whatever dislocations or mal-adjustments it has caused have speedily cured themselves by the growing demand for goods consequent upon reduced costs of manufacture. From the workers' point of view it has been reflected in an increased standard of wages and conditions of employment. Shorter hours have alone been possible because more could be produced in a given time. From the consumers' point of view—and every worker is a consumer—it has been represented in an increased standard of living. I could wish that the development of the technique of trade and commerce had kept an equal pace with the technique of industry, for of all the dislocations and mal-adjustments that now trouble us this is the prime cause. The structure of credit upon which the trade and commerce of the world is carried on is a delicate affair. No one quite understands the reasons which govern its growth and shrinkage; no one quite understands the ways by which it reacts in expanding and contracting the volume of manufacture and, with it, the amount of employment. We cannot yet regulate it as we should like. We cannot yet control it as we ought. If science could discover a curative treatment for the economic ills that beset us, how many of the misfortunes of to-day could be avoided! It is more science and still more science that we all need.

I have so far looked at the effect of science in production, and now I want to look at the effect of this science in production on labour. The first general observation which we may make is, that it has demanded a more highly skilled and specialized labour

upon the whole. Yet, even with this demand, room has been found for all classes of labour. For the specialization is intrinsically of two sorts—of men and of machines. The specialization of machines often enough calls for quite a limited measure of ability. It is a specialization which reduces a task to its simplest components and asks a worker to do one or other of them, and which enables the semi-skilled or even the unskilled to accomplish what was the work of the skilled. On the other hand there is the specialization of men which calls for a much enlarged measure of ability, because it places in the hands of a worker responsibility for a complex and elaborate piece of machinery or process. It seeks from a worker a knowledge and experience which only a long apprenticeship and training can satisfactorily give. In the old days it was always possible to tell a sailorman, because his habit and resourcefulness were stamped upon him. I believe nowadays it is always possible to tell a railwayman, for his employment marks him as the possessor of a tradition of conduct and craftsmanship, a tradition which has made our railway record so splendid. If it were not that we are all more or less engineers we should, I am sure, recognise them as a type too.

Bernard Shaw in " Man and Superman " has whimsically touched upon what he calls the new man, the engineer. The motor-car had just arrived in 1903 when this play was produced, and he with his readiness to snatch a topical subject and give it an enduring quality placed a chauffeur among his characters, 'Enry Straker. 'Enry puts his case briefly to his employer :

> " You'll get more out of me and a machine than you will get out of twenty labourers, and not so much to drink either.'

His employer draws 'Enry's character just as briefly :

> " Oh, if you could only see into 'Enry's soul, the depth of his contempt for a gentleman, the arrogance of his pride in being an engineer, would appal you. He positively likes the car to break down, because it brings out my gentlemanly helplessness and his workmanlike skill and resource."

This was in 1903, before the Ford car and the motor-bicycle had made every man his own mechanic ; and even this transformation is in the main attributable to the intensive application of science to the mass production of motor-cars, of which the Ford car is without doubt the supreme example. The Ford peace propaganda failed ; but it is to his credit that by his amazing activity he has, through his cheap motor-car, placed in the hands of the working-classes an instrument which has rendered an immense service in bringing peace to the industrial world in America. The almost

universal use of the motor-car in that country has been an effective antidote to Bolshevism. We are still a vast way behind America, where almost every other family owns a motor-car and where motoring has become the pastime of the common people. But we too are moving along. If we have abundant leisure and if we are not in the mood to undertake fresh work, we cannot spend that leisure better than by leaving our cities and towns and going into the country and so remaining in touch with a simpler form of life than that which we are now compelled to live in our vast aggregations of population. The countryside has never been known to breed revolutionaries. It has not the forcing effect of our urban communities.

This is by the way. The point that I wish to make is that in our leisure moments we are all accustoming ourselves to the handling of machinery, and that not of an easy or a simple type if you reflect upon the number of wireless sets which, for mere play, are now being made and used by all sorts and conditions of our people.

So, the epoch of machinery having reached its consummation, the problem of fluidity of labour is so much nearer being solved. We are more adaptable because we are more educated, more trained. In addition to the detail knowledge of our particular job, we all have the general knowledge that underlies machine jobs at large. We may have been slow at reaching this level. Our educational methods may have been defective. We may have lagged behind the Germans in technical schools and technical training, but we have got there eventually, and it helps to secure us against mishaps and misfortunes when innovations and improvements come. The more we have learnt, the easier it becomes for us to learn more.

In conclusion I want to return to the subject of our leisure. That is the gift of the machine. We have reached the eight-hours day, the 44-hours week. Our working hours are ceasing to be the greater part of our life and the all-absorbing. What are we doing with our leisure ? Once we served where the machine now serves, and we are become free ; but it is a freedom only to serve something else.

With this practical freedom has come other freedoms—of criticism, of thought, of speech ; and these have been used to a considerable extent upon the employers. (I speak of them collectively as a class). The trade union has been Labour's public school. The distinction between employer and employee is not so sharp and clear-cut as once it was ; and I, for one, should be glad if the distinction could be still more obliterated. I could

wish that Labour would use its leisure to learn the wider scope and nature of the business or industry in which it is employed, to interest itself in the difficulties and perplexities of those whose duty it is to manage the business or industry, to give them sympathetic support at times, and in putting forward their own demands or grievances to remember that the management are not dictators, able to do just as they would like, but are governed by economic laws which, if they fail to observe, may extinguish them. I am sure such a course would be helpful towards a better understanding and would widen the outlook and moderate the judgment. What is wanted is a new form of service, the helpful, unpaid service of an understanding and considerate staff.

With this practical freedom has come political freedom too. We have been made active citizens in the State and in the Empire. Here is a new field of service just as full of hard labour, just as exacting of strict discipline as the old field of industry, and I for one should like to see Labour in this new sphere seek the aid of all the sciences that help to mastery. The answer to the difficulties of politics and statesmanship, as well as those of industry, can only be won through scientific method, scientific analysis, scientific pursuit.

DISCUSSION

Major A. G. CHURCH, M.P., D.S.O., B.Sc. : I have listened to Lord Ashfield's address with admiration, not only for the matter which it contained, but also for the spirit which animated the whole of the address. Lord Ashfield is the chairman of a monopoly ; and the Labour Party is not, as you may imagine, against monopolies. On the contrary, it regards monopolies, if properly worked, as a transition stage towards something better, which is going to guide the destinies of the whole of this country and the whole of the Empire. But if you allow monopolies, the monopolies in their turn must be efficient, and they must supply the needs of the people in such a way that the whole of the population can feel satisfied that they have a trust which they are fulfilling to the best of their ability. That is the only justification for a monopoly. A monopoly does fulfil that trust more ably than any small body can do. Of course there are exceptions. There are small concerns which are admirable in their running ; but when money has to be sunk and when capital has to be put into research and into works, a monopoly becomes almost essential, or the association of individual enterprises in such a close-knit

co-operation that there is no essential difference between it and the more familiar type of monopoly.

Lord Ashfield has made reference to industrial disputes. These appear to me to be the outcome of the sordid political struggle into which this country was plunged the moment the Armistice was announced. Men who had shown during the War their capacity for service and sacrifice were forced back in a few days to the pre-war atmosphere of suspicion and distrust. An epidemic of general elections followed very closely upon the heels of the Armistice, so that nobody had time to readjust himself to his environment. I am not attributing base motives on the part of those who thus tested the country—but I may say this : that in the heat of the fray many of the finest ideals which had been in the people who had been to the front were lost sight of, and men then became disunited, struggling masses, whereas before they had been one consolidated and welded whole.

Science has gone beyond politics. It has gone beyond the administrative machine ; and I am inclined to think the present political machine cannot cope with the problems which are facing modern industrial life or modern social life in any community. I feel that we are all, particularly in the House of Commons, inadequate to the tasks which confront us. We are incapable, or the greater number are incapable, of solving the many urgent problems which are waiting to be solved. We are going to solve them only if we approach them in a scientific spirit. Science has no boundaries, science is essentially international. Science has no hates ; it knows no particular attachments ; science is a searching upwards and a searching out for the truth, recognising the whole of the time that it is but partial truth which can be obtained. Science has this message for the whole of mankind, that the tasks of the world will never be finished, and that science will multiply the tasks of the world. At the same time science will supply the whole world with the necessary leisure to engage in congenial tasks.

Although the lot of men is much easier than it was one hundred years ago, yet men's opportunities in life do not seem to have increased with the tremendous advances which have been made in scientific knowledge. Scientific discoveries applied all over the field of industry have enabled each person on an average to be about fifty times as productive as one person living a hundred years ago. In spite of that we are still working nearly as hard as ever. We have changed. Humanitarianism has succeeded a rather disgraceful period of exploitation. We have progressed ; but still we find that there is a cog in the machine somewhere. Some

of us say it is due to capitalism. Most of us know it is due in the main to a financial system which very few people understand, but which we know is capable of rather underhanded manipulation by certain sections of the community. And yet, as I say, very few of us have mastered its intricacies, and very few of us have any real appreciation of the effect of withdrawing credit or the effect of creating credit over the vast field of industry. Fear of the results of any change of policy will prevent any policy from becoming effective, until you have changed men's minds, and until you have attuned the minds of captains of industry and industrial workers, until you have brought them nearer to mutual understanding than you have at present.

It is suggested that we ought to abolish the limited liability system which has divorced a great number of the directors of industry from the people working for them. I cannot see how that is to be done. For my part, I want to sweep away the National Debt in the quickest possible way. One great contribution to industrial organization is due to the present Speaker of the House of Commons who inaugurated the Whitley Councils of employers and employed. I know these are not viewed with a great deal of favour by certain industrial people on both sides; but at the same time they have this good effect—they bring masters and workmen together in a way that was not possible before, and from that point of view they have performed a useful purpose. From my own experience of those Councils, I think they are the best that have been devised hitherto. You have, as I say, master and man meeting together and discussing things in common, and that will spread, and the more it spreads the better it will be for industrial life, and the easier it will be for us to tide over industrial troubles at the present day.

Sir RICHARD GREGORY, D.Sc.: Coal-mining offers a good example of the partnership between science and labour. Two hundred years ago only a few tens of thousands of coal were produced in these islands, and you could not produce more because mines could not be worked below 200 feet. Newcomen's pumping engine, and then Watt's engine, enabled this depth to be increased; and now with modern engines and electric power, you can go down 3,000 feet, and can produce 300 million tons a year, entirely owing to the application of science and invention to production. The result is that employment is now given to a million miners, whereas formerly there were only a few thousands of miners in this kingdom. This is an example similar to that which Lord Ashfield gave, of the increase of the employment of labour by

the development of the London General Omnibus Company on scientific lines.

Great transformations have occurred in the whole of the contions of industry through science ; and what we suggest is, that these transformations demand similar changes in the organization of industry. We have made great advances in mechanical processes and industrial development ; but there has been no corresponding change in the relations of employers and employed. The whole of the industrial organization must be considered from the point of view that science is now the dominating factor in industry and that the old working and social conditions affecting employers and employed have been altered. In my own view, industrial methods need reorganization in order, in the first place, that the fullest use shall be made of the capacity and talent of every worker which is not achieved in these days of mass production, so that the ship of State may not be entirely destroyed by modern industrialism. The new conditions of industry, in other words, demand a new system of industrial management ; and it is really a matter for consideration not only among employers but also for our rulers in the Houses of Parliament, to decide what should be done to adapt life to the new conditions which modern science has brought about.

Another question that might be profitably discussed is whether a craftsman who is displaced from his employment by the introduction of improved machinery, may not reasonably expect the State or the industry to see that provision of some kind is made for him. Wise administration should mean that all who have co-operated in the work have claims to recognition of their established expectations ; and that therefore when men are displaced through new methods or processes, opportunities should be provided for them to take up other occupations or their well-being otherwise provided for. That is a point of view which should be considered by the State ; and it is the only way in which one can expect operatives to welcome developments of industry through science.

Sir Dennis Bailey, Mr. W. H. Smith, and Mrs. Jessie White, D.Sc., also contributed to the discussion.

CHAPTER IV

SCIENCE AND THE HUMAN FACTOR

The addresses printed in this chapter were given at the Fourth Session of the Conference on Science and Labour held at the British Empire Exhibition, Wembley, on the 31st May, 1924, Miss Margaret Bondfield, M.P., in the Chair.

Miss MARGARET BONDFIELD, M.P.: The subject for discussion this morning is Science and the Human Factor. I am personally extremely glad that this human factor is being given a special session all to itself. There are a great many people in industry to-day who are inclined to fear the march of science in industry because the only manifestation they have seen of it is a tendency to a great regimentation of human beings, and they are naturally in revolt if that is all they see of it. The object of this Conference, I take it, is to endeavour to widen the scope not merely of observation and knowledge, but of the sympathies, particularly of the workers concerned, in the difficulties of any experimental period. There are bound to be manifestations other than those expected by the promoters during an experimental period. I am reminded of one incident that happened in a factory where the Taylor system, for example, was put into operation with great enthusiasm by the management without any sort of previous explanation to the workers concerned, and at the end of five or six months' experiment they abandoned it altogether because the workers objected to being told to stop work for precisely fifteen minutes. They did not feel that they wanted to stop work precisely for fifteen minutes at precisely the moment the management said they had to, and, above all, they did not want to sit still as the management insisted they should. In all possible ways that sort of stereotyping is to be avoided. It is not necessarily involved in the scientific method, and it is important to understand exactly how these things which appear so splendid to the scientific mind may appear to the unfortunate unscientific individual who is being experimented upon.

But the points in connection with the immediate programme of the application of science and its effect upon human life are so obvious, that I am quite sure there will be no difference of opinion here this morning with regard to them. Take, for example, this question of the importance of personal responsibility in matters of physical health. You may make the most perfect laws in the world; you may have the most perfect administrative machinery; but unless you also get the intelligent co-operation of the individual,

while much can be done by legal enactment and administration, you will not get the complete effect of the advanced knowledge. Therefore, how to enlist the understanding and sympathy of the individual worker or citizen is a part of the problem which the scientific initiator has constantly to bear in mind. This is an age of collectivism. As a Collectivist myself with a profound belief in the desirability of a change in the direction of a co-operative commonwealth, I am equally impressed with the importance of not decreasing but of increasing personal responsibility. Without that steady rise of personal obligation coincident with the improvement of our conditions, both in regard to industry and in regard to government and local administration, you have an incomplete machine and the human factor will spoil your most beautiful paper schemes.

There is another point upon which I think public opinion is getting very rapidly ripe : that is the importance to this particular island of more light, in every way, but particularly more sunlight. That, of course, raises the whole problem of the smoke nuisance. I sometimes feel ashamed when I go to other industrial countries where they have applied electrical power, for instance, where they have abolished the smoke fiend, where they can keep their houses clean, and the housewife has not to bother about changing the curtains every day in order that the windows may look decent. I come back to some of our Lancashire towns and in some of our oldest industries where I find a condition of things which is a disgrace to the controllers of those great industrial concerns and to the general body of citizens. It is a disgrace because in the long run it would pay them, even from the point of view of industrial returns, to take active steps to decrease the smoke nuisance by scientific methods which are now very well known, and above all by a very great development of the use of electrical power. We are only beginning to understand how great an effect our smoke has upon the energy and upon the physical well-being of large masses of our people. In that respect also I think a very great advance is within the realm of practical politics if only public opinion will insist upon this matter being attended to.

There is the question also of industrial fatigue. Some large employers of labour have already realised what it means to the output if the men and women employed in their factories start fresh in the morning, instead of with the remains of the last day's fatigue still heavy upon them. Relief from fatigue is going to be a very great factor which will have a commercial value, and from that point of view probably will receive more and more attention

as the days go on. Scientists regard it not so much from the standpoint of pounds, shillings, and pence in a particular business, but from the point of view of the value to the nation as a whole of having a people who are physically fit and capable of making the necessary effort that will have to be made, intellectually as well as physically, if we are to hold our own amongst the nations of the world. This country has, I think, come to a very serious stage in its history, and it will depend largely upon the way in which it applies science to its industries as to whether it is still going up the hill, and whether it is still going to be a leading industrial nation in the world, or whether we shall have to see our industries steadily taking second or even third place in the markets of the world.

These matters are matters of vital concern, not merely to those engaged in industry, not merely to the wage-earner and the employer, but to every section of the community. We, therefore, ought to welcome wholeheartedly the efforts which scientific people are making at the present time to give us the necessary information which will guide us in our industrial development, and we ought to allow no prejudices and no old-fashioned conservatism of mind to stand in the way of making such advances as are necessary in this connexion. There is the type of mind which says, " My father always did it this way ; it was good enough for him, and it is good enough for me." That attitude of mind is fatal to the development of this country. We cannot afford to rest upon the methods of our fathers when science has shown us finer and better and newer methods for doing the same kind of work and doing it in larger measure.

There is another point which I am sure will be dealt with in the discussion this morning ; that is, with the tendency of industry to develop by means of mass-production, methods, specialization, the differentiation of processes, and so on, so that masses of work-people are confined to the manufacture of a thirtieth or even a sixtieth part of the completed article. Some change of occupation is necessary in order to maintain a level of mental activity amongst the workers in connection with their work. Those who are in the position of organizing work in the factories will be required, I think, so to arrange their staffs that no one is kept upon a particular automatic process for too long a period at a time, and that there should be a possibility of changing over to new work. I know some employers say that is uneconomic ; that the great thing is speed, and if a particular girl reaches her maximum speed on a particular process, they keep her at it. But in the long run I

am sure that is wrong. It is wrong because you have to consider not merely the point of speed at a particular moment of time; you must surely consider what its effect will be upon that particular human being, and if the system turns out automata instead of live men and women, then it is a system which must be condemned. There may be some process of manufacture where changes are impossible. In that case I hold that the hours of labour should be reduced to a very small number and that efforts should be made to enable that particular human being to widen and develop the faculties he or she possesses in other forms of recreation or study or social endeavour. In any case, with the development of speed and mass-production, there is more and more necessity to pay attention to the development of the human factor. Our Lord said, "the Sabbath was made for man, and not man for the Sabbath." Industry is made for man and not man for industry, and if industry is not serving mankind there is something wrong with industry. I am aware that these ideas are not widely met with so far in industrial circles; it is necessary by means of a broad-minded and educated public opinion to secure the application of science to industry not only from the point of view of production, but mainly from the point of view of its effect upon human life.

PROBLEMS OF PUBLIC HEALTH

Sir ARTHUR NEWSHOLME, K.C.B., M.D.: Science may be defined as the accurate knowledge of phenomena and their causation; and the application of this knowledge is the chief means for securing human efficiency.

In dealing with the too prevalent human inefficiency and failure, we have a double problem, individual and communal; and our hope of social amelioration lies in securing accurate knowledge of the factors producing both social and individual inadequacy for the work of life and in removing these factors. In seeking for the causes of evil we cannot afford to overlook either physical or mental factors; and it implies an imperfect realisation of the factors involved if we leave character out of the reckoning. No completely satisfactory improvement in human conditions can be secured which omits from consideration any one of those aspects of human nature.

To take a single illustration. We are finding that a large part of the mass of insanity in the community arises from toxœmias and infections. Probably more than one out of every ten admissions to our lunatic asylums is of patients whose insanity is due

directly to the virus of syphilis which, given the absence of sexual promiscuity, would cease to be spread. The same illustration shows the importance of character as an element in social efficiency. Mental hygiene cannot be discussed in this paper ; but an essential element in the prevention of syphilis consists in the successful building up of the powers of inhibition—in other words the creation of right habits—beginning in infancy and in the toddler's stage of life.

The close inter-relation of conduct and health is seen also in our national habits as regards alcoholic drinks. These are improving ; but, nevertheless, these habits can be classed with syphilis, with tuberculosis, and with cancer as the four greatest causes of social misery and disease. Three of them can be removed from our midst, by efficient and adequate action, and yet, knowing the extent of the evils and their causation, we fail to act adequately for their removal ! The wastefulness of this neglect is seen in the fact that the alcohol consumed per head of the population in Great Britain in 1923 was estimated to cost £7 2s. 0d. : or, assuming that of the ten million families, one million have no drink bill, it averaged £35 per annum for each non-abstaining family. Two of the greatest needs for the children of the community are improved housing and a larger supply of milk. But the beer drunk costs more than the milk which is drunk ; and the money which would enable most members of the wage-earning community to pay an economic rent without any Government subsidy is diverted to what at its best is a luxury, and in a vast number of cases is a chief factor in the causation of poverty and disease.

Two favourable points emerge in considering our social problems on their human side :—

1. There is a general anxiety to help to lighten the burden of social misery—already lightened as compared with the past, though still grievously heavy—a burden making successful family life, on which civilization is built, difficult or impossible for a large portion of the population. The social conscience is being aroused.
2. We are ascertaining—and this knowledge is becoming a conviction—that the greater part of our social misery is avoidable if only we are willing to substitute rational causal attack on it for the empirical treatment of its symptoms.

Our chief social problems centre round poverty and disease, and these two are so closely inter-related that constantly cause and effect act and interact in recurring circles embracing every part of our social organization.

I propose to consider chiefly that *vast amount of poverty* in the sense of destitution, which *can be obviated by preventing sickness.* In all probability more than half our total poverty, including the poverty incidental to widowhood and orphans, is due to sickness. As stated in the Report of the Royal Commission on the Poor Laws, " One-third of all the paupers are sick, one-third children and one-quarter either widows encumbered by young families or certified lunatics."

The relief of poverty at the best is an inefficient and expensive remedy. It is seldom adequate and it *has few preventive elements;* while the prevention of poverty by the prevention of the illness causing it, and by early and satisfactory treatment of such illness as fails to be prevented, is the only efficient, as well as in the long run the only economical, plan of campaign.

How have these general principles been applied in our three great national services of Poor Law, Public Health and Insurance ?

So far as *Public Health* is concerned, I do not propose to repeat the oft-told story of its many triumphs. It is especially concerned in the removal of the causes of sickness and in securing the conditions favouring an improved standard of health. That it has still vast work to do is indicated by the simple fact that only 36 out of every 100 deaths occur at ages over 65. Every death at earlier ages means that the debt of the individual to the community has been incompletely paid back. The magnitude of this economic loss is shown by the fact that 39 per cent. of total deaths occur at the working years of life, 15-65.

How far are the Poor Law and Insurance helping Public Health ? So far as the sick are concerned Poor Law organization has been greatly improved, especially in our large towns, though even in these there is still commonly inadequacy of both medical and nursing staff. At the present time about 98 per cent. of the population who receive Poor Law relief are the sick and infirm, the aged and children. But the essential defect of the Poor Law is that it only operates when destitution has already arrived. Alleviation of suffering—relief—and attempt at cure of an established evil are sacred functions, to which we are bound as a civilized community to devote all needed effort, and there will always remain scope for measures to alleviate unpreventible sickness, or sickness for the prevention of which our preventive measures are not yet organized or completed. Prompt and efficient treatment of sickness again is a means for expediting recovery, and thus has important preventive elements. But *the fundamental principle of the Poor Law as regards sickness,* and also as regards all forms

of "unmerited poverty" *is objectionable.* Relief is available only when disease is already established and is associated with destitution, and the Poor Law system brings to bear on sickness, though in recent years to a greatly mitigated extent, mischievous deterrent influences which are only justifiable for the idle able-bodied.

Sickness is a thing apart, and for everyone, for the sake of national efficiency as well as of our common humanity, its treatment ought to be adequate, prompt and skilful, without any social or economic distinction between applicants, so far as essentials are concerned. Nothing short of this can continue to satisfy the intelligence or the conscience of the community. To continue to mix up this administrative problem with that of dealing with vagrants and the able-bodied destitute, is an anachronism which has long survived the period of enlightenment at which we have arrived.

This delay in securing the *needed divorce between the treatment of sickness and the Poor Law organization* is a factor in preventing increased application of measures for removing the causes of vast masses of sickness, as well as in preventing prompt treatment before destitution, in one or other particular, necessitates appeal to Poor Law help.

The remedial action indicated is well known. It is agreed by every political party in the State that the treatment of disease, so far as the State makes itself responsible for it, is a function of the Public Health Authorities; and yet this responsibility continues to be scattered among various local Authorities, Public Health, Poor Law and Insurance Committees, having no official relation with each other, acting independently of one another, their efforts defective in many directions, redundant in other directions, and only one of them inspired with constant ambition or possessing the power to diminish and prevent the sickness which they are called on to treat.

We are prepared to supplement, and ere long we shall probably be supplementing, apart from poor law provisions, the income of the widow with children, who without such help cannot satisfactorily rear her children. It is in the communal interest to do so. But the major duty is that we should make more strenuous effort to reduce the risks of accident, sickness and death which necessitate these pensions. Probably one-third of the total sickness and something like a fifth of the total deaths in Friendly Society experience are due to pulmonary tuberculosis, a disease against which our efforts social, industrial, medical and hygienic are still half-hearted and partial.

Similarly we, though somewhat half-heartedly, give milk to needy mothers and infants at child-welfare centres, and to school children suffering from malnutrition; but there is an almost complete lack of practicable machinery to prevent a large share of the family income in some of these families being spent on beer or whisky. A large proportion of crimes of violence, of sexual crimes and vice, and much of the neglect of mothers and children bringing burdens on public funds, are due to the intemperate habits of a minority of the population. We can appeal successfully to the intelligence and consciences of the majority of the population in regard to this; and the improvement of our social habits is evidence of the success of such appeals.

Education in its widest sense has worked miracles, when the term is used to include not only intellectual instruction, but also the training of the individual in behaviour in the varying circumstances of life, a training which, if it is to be successful, must be far advanced in infancy and in the pre-school period of life. But as a communal problem, there remains for a minority of the population the need for compulsory restriction of consumption of alcoholic drinks in the general interest of the community; and to the extent that the majority demand this it ceases to be compulsion, except for the minority who continue to cause a vast amount of avoidable suffering by their intemperance. For several centuries restrictions on the sale of alcoholic drinks have been demanded in this country and been adopted in varying degrees; and continuance and extension of these restrictions become increasingly practicable as the alcoholic habits of the majority improve and the evil results of alcoholic excess become more limited in their distribution. Such restrictions are among the most urgently needed public health reforms; and diminution of crime, of vice, of accidents, of sickness, of orphanhood and widowhood, would be the prompt result of action on the lines indicated.

The defects of our Poor Law medical system have been indicated; we may now turn to our *National system of Insurance* for a further illustration. The Poor Law system has failed because of the evil administrative link between destitution and sickness, sickness *per se* having no claim on assistance. In this respect National Insurance was an important step forward. Every insured sick person can claim medical benefit, as well as temporary partial maintenance during the continuance of disabling sickness. Insurance against sickness is a social service of proved value, as shown in the long-continued experience of Friendly Societies, in whose hands it has been also a valuable means of promoting

thrift. Since it was merged into a service which is national in extent it has lost much of the value it owed to mutual co-operation and the encouragement of thrift ; and the overhead charges and complications, under the present system of distribution of insured persons, have proved to be almost unbearable, while much of the old co-operative spirit has disappeared. The moral value of compulsory insurance is little if any greater than that of taxation.

I am not concerned here with the terrible difficulties on the administrative side of insurance which will need shortly to be faced. These relate among other things to the excessive cost of the system, due to the present conditions of administration ; to the constant tendency towards the " segregation of good lives " ; to the absence of any geographical or occupational distribution of the insured ; and to the non-correspondence between the monetary allowance in sickness and the duration of the need for this.

The struggling and the sick in the societies in which they are most numerous need most and get least, which is contrary to the spirit of all public health work ; inordinate and extravagant book-keeping and correspondence are involved in the present non-geographical distribution of members in societies ; and chaos of insurance administration is ensured by the fact that insurance committees are local, while societies of insured are not similarly localized, and the further fact that insurance committees are not organically related to public health authorities.

On the medical side, is insurance as now organized a handmaiden of public health ? It is a safe proposition that although *insurance* in itself is a valuable provision for contingencies, it *is harmful to the extent to which it conduces to contentment with* the *status quo* and to failure to provide means for diminishing the evils insured against. The Workmen's Compensation Act is open to a similar objection. In itself it has little or no influence in reducing the number of accidents ; and in this essential respect the administration of the Factory and Mines Departments of the Home Office stands on a much higher platform. In America, and to some extent here, this antithesis is being recognized ; and the extensive issue, at the expense of insurance societies, of pamphlets and notices on " safety first " represents valuable social work as well as sound business instincts. Let us not forget, however, that unless carefully safeguarded, insurance against sickness, like Poor Law work, will not diminish the evils relieved by them.

Our present national system of insurance against sickness is hitherto a most imperfect instrument even for the treatment of disease. The great majority of cases medically treated by the

doctor in his contract are slight in character ; and voluntary and Poor Law and public health hospitals provide for a high proportion of the total serious cases. There is extremely inadequate provision for medical consultations in difficult cases, for the treatment of various diseases needing the skill of the specialist, for skilled nursing, and for dental treatment. Above all, there is relatively little provision out of insurance funds for hospital treatment of thousands of patients who, without it, cannot be successfully treated.

As illustrating the chaos which is associated with the National Insurance Act, insurance committees were definitely precluded from entering into agreements with Poor Law Guardians for hospital provision. This restriction was not associated with or followed by the necessary proposals for transferring Poor Law infirmaries to public health authorities, and thus unnecessary suffering has been inflicted on Poor Law and insurance patients alike. Many of these hospitals are now " highly equipped general hospitals supported by the rates," and their more general utilization is urgently needed.

Reference has been made to the impotence of the National Insurance Act, in present conditions, as an instrument for the detection and removal of excessive disease. Section 60 of the Act of 1911 was intended for this purpose ; but its uselessness was emphasized when the Act was a Bill, by those competent to protest, including the writer. Insurance committees in their present isolated position have no expert advisers in hygiene ; they have no means for making statistical or epidemiological investigations ; and in most instances the absence of geographical or occupational classification of the members for whom they arrange treatment makes such inquiries impossible. It was furthermore obvious from the beginning to those experienced in administration that an organization for making such investigations distinct from and perhaps intended to be antagonistic to public health authorities was almost necessarily futile.

The national system of insurance against sickness has become an established part of our national administration, and the problem is how, in the light of the considerations already urged, it can be made to subserve the interests of public health and thus diminish the evils insured against. Only a few categorical suggestions can be made here, which must be discussed elsewhere.

1. No system of medical attendance is satisfactory which separates the insured person from other members of the same family.

2. No system of medical attendance approaches the ideal, which does not provide for the family physician being the medical adviser in health and not only when minor complaints or more serious disease occurs.
3. This implies an occasional overhaul of the insured person's domestic and industrial circumstances as well as of his medical condition.
4. The provision of medical attendance, and of all benefits ancillary to it, should be on a truly national basis, with equality of benefits to all according to need, and short of this the insurance system cannot become entirely satisfactory. At the least the detailed application of special additional benefits should be centrally controlled.
5. There is needed above all an intensification and extension of public health work, in improved housing, in protection of food, in an improved and increased milk supply, in factory and workshop hygiene, in education of school children and adults in health matters, and especially in additional action called for to diminish the evils caused by alcoholism, by venereal diseases and by tuberculosis, the three greatest causes of premature and preventable, mortality—in the aggregate causing one-fourth of all deaths from all causes—which are responsible for a very high proportion of the sickness against which we provide sickness benefits, while not doing our duty to secure their more rapid disappearance from our midst.

INDUSTRIAL PSYCHOLOGY

Dr. C. S. MYERS, C.B.E., M.D., F.R.S. : The human factor, which we are dealing with to-day in relation to science, may be treated from various points of view—the medical, from which Sir Arthur Newsholme has discussed it, the physiological, and the psychological. I am going to deal, as you may expect this morning, with the psychological aspect of it, which includes, of course, a certain amount of physiology, because mind and body are inseparable ; and I want to indicate how science can help this aspect of the medical factor and how it is helping it. We have now a rising new science known as industrial psychology, concerned with the human factor in industry. It studies one branch which I shall dismiss almost immediately—the mental factors affecting the distribution of the products of industry, such as advertisement, designing, vagaries of taste, selling and buying. It may be news to you that you can have anything of a scientific

inquiry or anything approaching a scientific inquiry into such matters as these, but I can assure you that it is being done. For instance, with regard to advertisement, one can experiment as to the influence on subsequent recall determined by the position of an advertisement in a page, the size of the advertisement, the distribution of its repetition, and so on. You will easily realize endless ways in which such experiments can be applied, but I think that here to-day we shall be more interested in the second branch—the mental atmosphere within the factory and what science can do in that respect. That comprises first of all the relations of the worker to other human beings, and secondly the relations of the worker to his work.

The relations of the worker to others, whether superiors, equals, or inferiors, is, I understand, a subject to be dealt with this morning by Miss May Smith. With regard to the second point, the relations of the worker to his work, we had hoped to have here to-day in the first place Dr. Legge from the Home Office, and in the second place Mr. D. R. Wilson, the secretary of the Industrial Fatigue Research Board, to deal more especially with one factor which Miss Bondfield has emphasized—the physical environment of the worker. She particularly referred to lighting, and there are also, of course, similar factors—vibration, noise, temperature, humidity, and the like. I am afraid I cannot deal with them this morning. With regard to the relation of the worker to his work, you will have a second factor to consider—vocational aptitude, of which I am glad to see Dr. Burt is going to treat. And thirdly you have the study of the rate of output and movements of the worker. To this I propose to confine myself—time and movement study.

The objects of time study, as originally developed by the industrial engineer, especially in the United States, were mainly to establish a fixed standard of speed to which the workers must conform. But we have now come to the conclusion, largely through the outlook of the physiologist and the psychologist, that emphasis on speed is apt to mean flurry, and to encourage needless movements. Through industrial psychology we aim now at increasing, not the *speed* of movement directly, but the *ease* of movement, whereupon speed follows. Then again, as originally developed by the industrial engineer, especially by Gilbreth in the United States of America, movement study attempted to establish a single fixed standard of method of movement, "the one best method," as Gilbreth called it, which was to be forced on all workers, regardless of individual differences in natural style. This again is

a grave psychological error. Through the influence of industrial psychology we aim now, not at enforcing any *one* good style, but rather at avoiding and correcting bad styles. We recognize that there are *many* good styles of work, and we no longer force all the workers into *one* style for which many may constitutionally be unfitted.

We may consider time and movement study under two main heads—gross and minute. "Gross time study" involves the determination of quantity or quality of output at different periods under different conditions. We may investigate how output varies hourly and daily. Miss Bondfield alluded to the importance of seeing that there is no great residuum of fatigue left over from day to day, so that we do not get a decreasing daily output throughout the week. Hourly, daily, and seasonal variations have to be studied. Closely connected with this study, "gross movement study" investigates the effect of improved posture and position and arrangement of material. I do not know how far you may care to have instances of that kind of thing. My own experience is confined to the Industrial Fatigue Research Board and the National Institute of Industrial Psychology. In this connexion I often quote one of the first pieces of work the Institute did, namely, on the packing of chocolates, where an increase of output of 35 per cent. was obtained through easing the movements of the worker, when, despite this success in output, the workers expressed their gratitude to the investigator, saying that they went home very much less tired at the end of the day than they had previously done.

Similar investigations have been carried out with regard to improving the conditions of the miner at the coal face, much to the workers' appreciation, as you will find from the accounts in the Institute's Journal, which record increases of from 10 to 20 per cent. respectively obtained by improvements in the miner's movements and in illumination. Then, to pass to a closely cognate branch, we have to consider investigations dealing with the amount of spoilt work. Breakages are part of spoilt work. Investigations carried out by the Institute on the breakage of china and glass for two different firms resulted in a diminution of breakage, in one case of 53 per cent., and of over 44 per cent. in the other, in each case combined with smoother running; at the same time gratitude was expressed by the workers, which is the point I want especially to lay stress upon. Thus one of the girls in the second investigation —the result of which has not yet been published—made the remark, "We are in clover now"; and if you saw the reduction

of irritation and excitement and annoyance which has been effected by these two investigations and how smoothly things run compared with the way they went formerly, you would appreciate what science is doing for the human factor.

I will not occupy time in describing the effects of rest pauses and of change of work and of length of spells of work. The importance of these points has already been alluded to by the Chairman in her address this morning; but you can think for yourselves how few are the industries where output could not be increased by some interruption during a continuous spell, say, of four or five hours without a break. What happens, of course, under existing conditions, is that a very great deal of time is wasted in surreptitious rests; whereas if there were a general break, not in the noxious way that Miss Bondfield has described, but with the co-operation and full approval of the worker—a break for rest spent in a congenial manner—it would be of great benefit to the worker.

Gross-time study is obviously of great importance too in fixing piece rates and arriving at a fair distribution of piece-rate work of various kinds. Where you have piece-rate work of different kinds, it often happens that one is an easy piece-rate and another a hard piece-rate, and you get an unfair distribution of work, perhaps through favouritism on the part of the foreman; but careful work in time study in this direction will do away largely with the discontent which has thus arisen in the past.

Gross-time study is also valuable with regard to training, and the effects of training upon output. You will be surprised to hear how enormously output can be increased by improved training. I have not time to go into the details, but one instance is recorded by Mr. Farmer and Mr. Brooke, working on behalf of the Fatigue Research Board, where the rate of output went up by something like 50 per cent. That was the effect of systematic methods of training. By training the less efficient workers, the number of strokes they employed diminished by 40 per cent. The work that they were engaged upon was the process of polishing spoons and forks against a rotating wheel. Then, of course, gross-time study is important with regard to the amount of avoidable lost time. Time is lost in refixing machines, when they are used now for one process and now for another; there is loss of time in unproductive labour, and in unexpected or unsystematic waits which cause annoyance and lead to consequent inefficiency.

I come now to "minute-time study," which consists in the determination of the length of time required for the performance of each movement or each group of movements involved in an

industrial operation. I do not know whether you have seen the work of "buffing"; that is the work I have already referred to, in regard to which Mr. Farmer and Mr. Brooke have recorded the results of their investigations. They arrived at the interesting result that as fatigue comes on, the movements of the worker—the strokes of the worker—become more frequent; they also become more powerful, and there are longer pauses between the strokes. There is a wasteful expenditure of energy and at the same time a diminution of output.

A great deal can be done merely by the stop-watch, but one must, of course, have the co-operation of the worker in this work. Taylor's notion of introducing the stop-watch secretly is impossible either in this country or in any other, I should imagine. Timing cannot be carried out unless the worker knows what is being done and gives his full sanction to it. I may say that in all the work we have been carrying out in this new industrial psychology, if it is to be carried out satisfactorily, we must have, and we have had, the full co-operation of the worker and the realization on his part that we are out, not directly to speed him up, but to make his work easier—that is to say, to improve the human factor. Recurring to gross-movement study, we have had to consider the arrangement of the material, the size, the position, and character of implements which the worker uses, and which are often very ill-designed for the purpose. The engineer is a gross sinner in this respect, putting levers and pedals in places where they are most unsuitable for the physiological requirements of the worker. Then we have to consider the posture of the worker, the needless sitting and stooping, and so forth. After such preliminary study we come to minute-movement study—the study of the actual movements of the limbs, of the arms, hands, and fingers, involved in a given occupation.

This will give you some idea of what can be done in the one particular branch of industrial psychology which I have selected for dealing with this morning. I have chosen that branch because, as I have said, there are other speakers following me who will deal with other branches. The instances I have given you will afford some idea of what this latest science can do with regard to the human factor. Of course, one knows that as you get higher and higher in the region of scientific inquiry you become necessarily less and less exact; so it is that the mathematician looks with a certain amount of scorn on the physicist, the physicist with still more scorn on the chemist, and the chemist looks with scorn on the biological chemist, and the biologist looks

with still more scorn on the psychologist. But we are all using and dealing with the same scientific methods. One of the greatest interests in psychology is the enormous complexity of the work with which we have to deal—the great individual variations. It is one of the vast attractions of the subject that it deals not with averages, but with the different results from different individuals. It is interesting to observe that the further chemistry and physics go, the more clearly they are beginning to discern minute differences which turn out to be more profound than they had at first supposed. That describes to you, in the few minutes I have been allowed to devote to it, some account of what industrial psychology is doing in our special branch of the subject to-day.

VOCATIONAL SELECTION AND GUIDANCE

Dr. CYRIL BURT, M.A., D.Sc. (Psychologist to the London County Council) : I have been asked to speak to you upon one special application of science to the human factor—Vocational Psychology. Vocational psychology has two main branches, and pursues a double aim ; it seeks, first of all, to find the best man for any given job, and, secondly, to find the best job for any given man. Those two aims it pursues by making careful observations, by carrying out systematic experiments, and applying and administering standardized tests, all in the spirit of scientific research.

Of these twin tasks, the former, the singling out of the candidate most suited for any particular position, is called *Vocational Selection.* This, obviously, is the task which is of greater interest to the employer ; and it is, fortunately, the task which is by far the easier of the two.

If any of you happen to be employers, let me ask you, how do you at present choose your employees ? The commonest method, I suppose, is that of engagement upon probation. Applicants are selected for no other reason than that the situation is vacant, and that the men have applied. There is usually a brief interview, varying in its length and thoroughness according to the responsibility of the position. But, for the most part, it is left to time and chance alone to discover whether the man fits the work and the work fits the man.

Let me quote just one inquiry to demonstrate the extravagant wastefulness of this spendthrift policy. Not long ago an investigator went round to a dozen factories to study the labour turnover. In these twelve factories 43,000 men were engaged, and of these 36,000 left or were discharged before twelve months had expired.

The commonest reason for their discharge was the unsuitability of the men for the job and the job for the men. A careful assessment of the cost of engaging each single individual showed that, had it been possible to engage the right man at the very start, nearly £800,000 would have been saved.

Physical science the employer is willing enough to utilize. Mental science—he hardly realizes that there is any such thing. You send your materials to be tested by the chemist ; you appeal to the expert engineer to advise you on the choice of plant. Yet surely the man plays a far more essential part than the machine ; surely the worker is quite as important as the materials he works upon ; and should be selected just as scientifically.

What is the method which the psychologist has to offer in place of the blind rule-of-thumb procedure at present in vogue ? He relies largely, though not entirely, upon what are known as vocational tests. A psychological test is simply a mental examination worked out and standardized upon scientific lines. The psychologist begins with what he calls a job-analysis. He makes a first-hand study of the nature and needs of whatever work the applicant will be called upon to do, studying the work from the inside, and sometimes becoming a hand himself. He observes and examines existing employees—good, bad, and indifferent. He tests the shorthand typists, the factory hands, the turners, the fitters and the packers, to see what qualifications are required for each trade-process, and how the best workers differ in constitution and training from those who are the most inefficient.

The result of such analysis has been the invention of a large number of standardized trade tests for each of the occupations I have named. We now have tests for dressmakers, for clerical workers, and for most branches of the engineering trades.

Dr. Myers touched at the end of his address on the extraordinary range of individual variations. Consider children at school. Children aged ten by the calendar may vary in their mental capacity over the whole range of the elementary standards. The brightest child aged ten, hidden away perhaps in a slum or in some rural district, may have intelligence equal to that of the average child of fifteen. On the other hand, the dullest child of ten may be upon the mental level of an average infant of five. No differences of mind are so well marked, so far-reaching, so easily discovered, or so unalterable as these differences in inborn intelligence. The same differences can be discovered among adults. In the tests which were made of some 40,000 Civil Service candidates the same wide variation was discovered.

Thus the commonest cause of industrial inefficiency is not so much putting the round peg into the square hole, as forcing the big peg into the little hole, and dropping the tiny peg into the hole too big for it to fill. In a certain English factory there were two chief processes that had to be carried out—the one dull, automatic, and mechanical, the other needing constant alertness, inventiveness, and resource. All the girls in that factory were tested for general intelligence. It was found that many of the dullest girls were engaged upon the most difficult work; while some of the brightest girls had been set at the mechanical processes, and had become exceedingly dissatisfied and discontented, and were apt to relieve their boredom by chattering, giggling, and disturbing their fellow-workers. When the intelligence of each one had been measured, the misfits were simply changed about; and, without dismissing a single hand, the output of the factory was nearly doubled.

The same principle is applied in the second main branch of vocational psychology—what is called *Vocational Guidance*. As you know, almost every child when he leaves an elementary school is given a school-leaving form which describes his character and ability, and states (or professes to state) the kind of employment which he may most suitably be advised to take up. At present, these entries are little more than kindly testimonials, put down in a hurry by the head master just before the boy leaves. It is the aim of vocational psychology to base that advice on a thorough preliminary study of each individual child, carried out perhaps during the whole of his school life, on a scientific basis, so that his various qualities, his special attainments and his special aptitudes can all be known before he comes to the Bureau for Juvenile Employment. With the aid of the London County Council and of the Industrial Fatigue Research Board, the National Institute of Industrial Psychology is actually carrying out investigations on these lines in several elementary schools. It is found, for example, that in their eagerness to give each child a clean respectable job, both teachers and parents are very apt to recommend for clerical work many backward boys who have not even the intelligence to spell the simplest words in a business letter. On the other hand, a very bright child may be missed, just because he does not happen to have passed a verbal examination in English; and is given a post of drudgery, although he may be just the type of child that would have profited by secondary or technical education. I was told yesterday by a works manager who had been carrying out psychological tests in a factory at

Bristol that when he tested all the hands in the factory one girl stood far above the others in the intelligence test of the packers. She was known to be a bad packer. And the psychological investigator called her up, and asked her why it was she did so well in the intelligence test, and yet was doing so badly in her packing. She admitted that she disliked the work. The manager took an interest in her and took her into his own private office and made her a sort of assistant to him, and she took the statistics and books in hand and is now one of the most efficient helpers in that particular branch of the factory. In fact, the firm is even contemplating sending her to a university. There you have the case of a very bright girl who had been in that firm for four or five years and who was never discovered either at school or in the factory till the works manager happened to give her this particular intelligence test.

The children themselves have not the remotest notion of what work they are fitted to do. The boys, for example, all want to be engineers, which they think means driving locomotives or else constructing wireless sets; the girls are, nearly all of them, secretly hankering to be cinema stars. Yet once they have been thoroughly studied and tested it becomes quite clear that these fancies and imaginations do not in the least represent what the child is best fitted for. Children's minds differ from one another almost as much as their faces do. Each child has some special aptitude or some special level of intelligence, some special line of work for which Nature has marked him out, and once that line has been discovered it is not difficult to find him a niche which he can suitably fill.

Vocational psychology thus aims at benefiting both the employer and the employee, the employer by selecting the best men, and the would-be employee by selecting the best form of work. It is thus a measure of industrial economy, a proposition that will pay. But it is also something more. Its first claim is to make for increased commercial efficiency, to eliminate the gravest of all forms of waste, the waste of human material. But it also claims a second and a higher purpose—to do justice to the natural powers of every individual, and so to diminish personal discontent, and to raise the welfare, the prosperity and the happiness of human society as a whole.

TEMPERAMENTAL TYPES

Miss MAY SMITH, M.A.: The point of view that I wish to bring before you is one with regard to which most people will agree in theory, but which in practice is very rarely recognized, namely,

the effect that the people in authority have on subordinates. I use the term " subordinates " in preference to " workers," because of the ambiguity of the word " worker." In the course of investigations of the type described by Dr. Myers it has frequently happened that an apparently straightforward investigation has been considerably hampered by conditions which were not in the least dependent upon the material state of the works, but upon the temperament of the people in authority. Perhaps the meaning will be made more clear if some of the types one meets are described ; these are not drawn from psychological theories, but from descriptions given by workers. The first type is very common in industry, and also in schools ; psychologically he—I use the " he " always as common gender—reacts, not to the situation involved, but to the emotion aroused in himself by the situation. Something goes wrong in the works, and this particular type of person happens to feel that it is rather a reflection upon himself that such a thing should have happened. He immediately goes off into a violent tantrum and abuses everybody, his language being dependent upon his vocabulary and his social class. Another time the very same situation may arise, and will be merely laughed at. The type is easily recognized by visitors to a factory for he cannot refrain from trying to impress his audience with his own importance. He points to a particular piece of work and says : " This is not the type of work we are accustomed to here." He is not really blaming anybody ; he is merely trying to show off before the visitor. This behaviour does not matter to the visitor but it matters very much to subordinates. A worker once described such a manager to me in these words : " He makes me feel all churned up inside."

Physiologists such as Cannon and Crile have proved to us conclusively the physiological effect of fear on the human organism, but it is difficult to get some medical men to recognize that the constant state of anxiety and worry, which is set up amongst the workers by the explosive type of person in authority just described, is likely to result in some nervous trouble ; it is not surprising that nervous dyspepsia, probably set up by these conditions, fails to be improved by a simple tonic. There is, however, evidence, the details of which cannot be considered here, that neurotic disturbances can be set up among workers by such a type of manager. He may be an excellent organizer, and from some points of view I am rather inclined to think that it is a type which tends to come to the top ; so long as he is so far removed from his subordinates as not to have to come into personal contact

with them, he may be allowed to go on in his own way. If he is a wise man he will choose a collaborator whose duty it will be to interpret him to the workers and others, and explain to them that he does not mean all he says. In those circumstances such a type gets on very well, but I have not the slightest doubt that where he comes into personal contact with the workers, such a condition as I have described is set up.

Some of the workers react to such a type, not with the " churned-up feeling inside," but with a state of utter indifference, so that they do not care either for the manager's praise or blame—in which case he, of course, fails to rule adequately. Surely if a person is in authority those under him ought to care about his praise or blame, and we are going to take an inhuman point of view if we think it seemly that those in authority should be treated with indifference. The damage would be incalculable and general unhappiness and distress result.

Secondly, there is the type best described as the " over-anxious " type. Nothing can ever be right, for the simple reason that this type can never be right with itself. The workers do not call it " over-anxious " ; they call it " nagging." Their point of view is " there is no pleasing Mr. So and so ; he is a nagger." Again one has this constant anxiety set up because of the nagging. It is exceedingly unpleasant even to an investigator, who is more or less indifferent to the temperaments of the people in works, to be in a department where there is a nagger in authority. Very often a nagger can be considerably improved by having it pointed out that he or she is nagging. I once thought that nagging was rather more characteristic of women than of men ; wider experience has shown me that it is a type among both men and women. To this type also some workers react with a general feeling of depression, or of sullen opposition, and I do not think we can ever calculate how many schemes have been ruined, and how many votes lost for a good cause by the opposition of people who are not opposed to the thing itself, but who are opposed to the person who represents that point of view or thing. Much of the so-called opposition to new methods in industry is entirely dependent upon the temperament of the person who introduces the methods, and not upon the methods themselves.

Another type is the one with a particular obsession—who has only one interest or mania, e.g., tidiness. You will find such a type over and over again. The workers call it a " stunt." They say " Mr. So and so runs a stunt " and they play up to the stunt. It may be that the person in question has a rooted objection to

a basket being out of place, and as soon as he comes along everyone runs and puts the baskets away, although they may be wanted at that very moment, and valuable time is thus wasted; or he believes that so long as you are moving your hands, or your body, you must be working. The foreman must not stand still and indulge in useful meditation; he must be moving. As soon as a manager with such an idea comes in everyone in the factory gets into a state of feverish activity. The attitude of the workers to such people is very much like the attitude of grown-up people to children: "Let him do as he likes; it pleases him and doesn't do us any harm." It means that they look upon the manager's obsession as a triviality, and they carry that criticism of Mr. So and so's triviality into everything that Mr. So and so does. If he wants to introduce new methods in his works he will be confronted with an amount of opposition which he will not be able to understand—just because his workpeople really despise him. He makes such a fuss over nothing that they come to think that nothing he says matters, and in such cases a certain laxity prevails which is good neither for the workers nor for the output. The successful ruler—and he does exist—brings to his work sympathy, tact, and above all humour; his own self-respect is so high that it prevents him from taking either himself or his office too seriously. He then gives a chance to those under him to get on with their work. If one had to take one criterion only in judging of a department, then the most valuable would be the appearance of happiness amongst those working in that department. Where there is happiness amongst the workers the output can be left to take care of itself.

There has been a tendency to emphasize the need for improvement in the more material aspects of factory life, but while every material improvement is valuable, still we must not overlook the more human side, viz., the interaction of the temperaments of authorities and subordinates.

DISCUSSION

Sir HUGH BELL, Bt., D.C.L.: I am probably one of the few people present who stand open to the condemnations which have been uttered by various speakers. I have been engaged in industry for a matter of sixty years or more and have, therefore, been inadvertently practising industrial psychology for a long period. One of the difficulties which we have had and are still having is to induce the persons in our employment, or whom we are about to employ, to believe that we have an absolutely common interest

and that it is desirable both for them and for us that the utmost amount of productivity should be acquired. It is not an easy thing to do. I have many a time had to say to the people in my employment: "I am going to try a new experiment. I am not going to tell you what it is because I know, if I did tell you, the one thing you would do would be to endeavour to thwart it. But I am in full sympathy with you, for this reason—that all improvements in the way of economic production mean a reduction in the number of persons actually employed for a particular job." Let us assume that there are ten persons employed on a particular job and I invent a way in which I shall only need to employ five. I am paying each of the ten workers some unit—we will call it £1—and I say to them: "Men"—I employ very few women—"Men, I have found a way by which I can do with half the number of those that I now employ. You are each of you getting £1. I shall give each of you 25s. in future." They say "That is all very well, but what about the five you do not employ?"—and the question is an extremely difficult one to answer. I can only suggest to you an answer which seems to me a complete one—that is that up till the unfortunate circumstances on which we entered ten years ago occurred I had been employing more men every year than I employed the year before; the wages of them all had increased. That is a sufficient answer from my point of view, but it is no answer from the point of view of Tom or Dick or Harry, who think that if I introduce this improvement their employment will disappear.

The one thing towards which we should all struggle is the inducing of everybody—employer and employed alike—to understand that the object we should aim at is larger productivity. The one thing from which we are suffering is that we are not producing enough. To many of us it is doubtful whether the total product of the nation is sufficient to maintain the standard of life which existed before the War, and towards which we hope to get back again and which we hope will improve as it has been steadily improving during the whole of my life, and—I say it with no disrespect to the National Institute of Industrial Psychology—without the intervention of any direct psychological effort. I am not undervaluing that effort. On the contrary, I feel fully the weight and the value of it, but the thing that we have got to do is to persuade the world that what is wanted is increased productivity. I am sorry to have to say that my forecast as to what would probably take place in the world by the action of Governments over the last forty years has been justified. We have more and more endeavoured to persuade people that they could get something

for nothing. The speeches which we have heard to-day have both directly and indirectly confirmed that impression. It would have been difficult to resist many of the measures which I condemned at the time—and which I now condemn—but in every case it ought to have been insisted upon that that which was being given meant a reduction of the remuneration which would come to the worker. It would take too much time to elaborate this proposition, but I should be prepared to defend it under all circumstances and on any platform.

Dr. Burt spoke of the methods of selection. People who, like myself, have been engaged on this kind of work for a long time have got a sort of intuitive power of selection, which I will compare with what I have been told takes place on some of the ranches in the Argentine Republic. I was told that a man accustomed to dealing with cattle in huge numbers could look at a couple of thousand cattle being driven through a narrow opening before him and that he could pick out at a glance one hundred of them with perfect certainty, and, without any psychological examination, would choose the hundred that he wanted and that that hundred would be quite sure to fatten the best of the lot. That, no doubt, was a psychological effort on his part, but it was a psychological effort of an intuitive kind which many of us hope and believe and feel satisfied that we ourselves possess.

Mr. Morley Dainow, B.Sc., Mr. W. H. Smith and Mr. M. J. Connell also contributed to the discussion.

CHAPTER V

SCIENCE IN EDUCATIONAL ORGANIZATION

The addresses printed in this chapter were given at the Fifth Session of the Conference on Science and Labour held at the British Empire Exhibition, Wembley, on the 31st May, 1924, Mr. Arthur Greenwood, M.P., B.Sc., in the Chair.

Mr. ARTHUR GREENWOOD, M.P., B.Sc. : It was a happy thought that brought together science and labour at this conference, the more so because labour, by hand and brain, in co-operation with the body of organized experience that we call science, would present a combined force which could overrule all prejudice and all privilege and be the real guiding force in the world. It is not for me to speak at length about the question of education, because there are others better equipped to deal with that subject than I am. But if I may make a general statement which I hope will not impose too great a strain on the speakers and steal any of their thunder—because their thunder is so much greater than my own—it is that this country has now reached a stage in its development where it must have a much greater regard for knowledge than it has had in the past. I believe that the careless, easy days are over, and that any community which hopes to maintain its people and its position in the world, which hopes to make its contribution to civilization, must get rid of the haphazard methods which sufficed this country before the war. If that be so, education becomes a social service of paramount importance. At each period of history, education has taken its peculiar place ; it has adapted itself to the needs of the society in which men lived at the time. The education of ancient Greece, for example, was different in its spirit and purpose and form from the education of ancient Rome, because those two types of civilization stood for different things. Similarly mediaeval education was different in its scope and content from the education required by modern industrialized communities feeling their way to democracy. In this country, I think, we are a little slow in adapting our educational institutions to the spirit of our age. We are becoming, whether we like it or not, a democratic community, in which the responsibility for the national life in all its aspects is being handed to more and more people.

Education, therefore, becomes a problem dealing with the whole people, and not with any section of the people. Education should be regarded as one of the processes whereby an

organized community brings to bear upon the individual all the formative influences that ought to be brought to bear upon him, partly as a member of the community—as a citizen, as a potential parent, as a future worker in industry—and also because of his claims as a person. I think the real principle to act upon is that the claims of human personality and the claims of society are complementary and not contradictory. Our educational system, therefore, ought somehow to develop personality in society. It is not for me to say how that should be done ; but as regards the organization of our social forces through our educational institutions, one thing we can claim in the past is that these institutions have never become so superorganized as to lose their adaptability. I think there is a danger, as education becomes more widely extended, of our institutions becoming more stereotyped and more watertight, and if that evil is not guarded against the spirit of education will vanish.

The other side of the question is not the question of organization ; it is the question of the content of education. It seems to me that, with the enormous growth of knowledge, the number of avenues through which education can be achieved are so many that there should be possibilities for the proper education of all people. Though this is a Conference of science and labour, I feel quite sure that the promoters of it would be the last persons in the world to narrow down the scope of education to natural science. Rather would they emphasize the need for organized knowledge in all branches, and educational opportunities need to be provided so that particular types of mind and particular kinds of intellectual quality should have their appropriate avenues for educational development. As I have said, it is not my business to deal with these questions in any concrete way. I am relieved from that. One can only deal with them in general terms.

Finally, may I say this : I believe that Labour in this country—in those manifestations of it which are organized through the Trade Union movement, through the Co-operative movement, through the Workers' Educational movement, and through its own political movement—is realizing much more keenly than it has done in the past, the enormously important place which education ought to hold in the community, and I believe that as time goes on Labour, through its various organizations, will become a great driving force in the interests of a broad, generous, humane education offered unstintingly to all people at all stages in their lives from childhood to manhood and womanhood. If we can get that conception of education as something to be offered and something

to be gained—not easily, it is true—by the masses of the people, I think that this country can face the future with a certain confidence.

EDUCATIONAL ORGANIZATION

Mr. R. H. TAWNEY: The subject on which I have been asked to speak is one calculated to embarrass those who, like myself, come to questions of science and of educational organization as laymen. There have been discussions at these Conferences on the relation of science to Government, to industry, and to the human factor. But before human beings can approach these great questions, before they can organize society and engage in economic activity, or devote themselves to the conquest of their material environment, human beings have got to be grown. Their growth is a complex and difficult process. There are some sides of it which we have only just begun to study, and about which we know comparatively little. Education, as I understand it, is the art of promoting growth. The aim of education is not to add certain accomplishments, or to indoctrinate the rising generation with the views which commend themselves to its parent. Its purpose is to develop latent powers, to enable children when they are children to be healthy children, in order that when they are men and women they may be able to define their attitude to the world for themselves. A scientific system of education is one which so organizes the resources, human and material, which are available for cultivating each new crop of human beings, that waste may be minimised, that powers may be developed, and that the latent endowments of successive generations may be made an actual reality.

Of course, those endowments are limited, and, of course, they differ enormously from individual to individual. Those of us in the Labour movement who are concerned with education are not under any sentimental illusion either as to the differences, or as to the limitations. But the criticism that education is relatively unimportant, because it cannot alter inherited qualities —that you cannot, as is sometimes said, put an edge on a leaden knife—seems to us to be based on a misconception both of the facts of our existing social order, and of what is claimed for education by the educationist. No sane man denies the fundamental importance of the differences which exist in individual capacity. But it nevertheless remains true that without easy access to prolonged education, special ability, except by a fortunate accident, will never even be discovered, and while the dullard

remains at the university till he is 21 or 22 years of age merely because his parents can buy education for him, the potential scientist, or administrator, or poet may be employed, and sometimes is employed, sticking labels on bottles in a mineral water factory. On the other hand, a high standard of universal provision is as important as the intensive cultivation of special capacity, since it is the condition of the mutual understanding and tolerance and appreciation on which the difficult co-operative experiment which we call civilization depends. If, in short, you desire a society in which the average individual is healthy and alert and responsible, such a society can only be cultivated by a high standard of universal education. I need not labour these truisms, because in this matter the appeal is to practical experience. The experience of the past, which is the province of that special kind of scientist who is called an historian, shows us that education has enormously raised the standard both of individual attainment and of social well-being. And anybody who is familiar with the conditions obtaining among children and young persons to-day, and who will compare the scale and quantity of our educational standards with the standards which are laid down by educationists, will not, I think, doubt for a moment that education is only at the beginning of its task. It is our business in this generation to remove the obstacles which impede it.

If we are to do that successfully we must approach the matter in the right spirit. The right spirit, I suggest, is neither that of a conservative nor that of an iconoclast, but that of a realist who desires to ascertain the facts, and to base his policy upon them. Educational systems will be effective in proportion as they are related, not to our economic conditions, or our social prejudices, or our passing intellectual fashions, but to the needs and capacities of the children themselves. Our educational system is an amalgam ; it is a composite product which has been built up under the influence of many different forces. What we have got to do is to disentangle those parts of it which are educationally relevant, because they have some educational meaning, from those not inconsiderable parts of it which are so much dead wood, and have no meaning at all except an historical one. We must envisage the problem as a whole, instead of, as in the past, handling it piecemeal. And we must insist that our practice shall be invigorated by research and by criticism based upon it.

We must begin with a very simple matter, the physical realities of child-life. Thanks to the brilliant work done during the last

fifteen years by the School Medical Service, we know a good deal about them. But I am afraid that public opinion has even yet not realized that the attempt to limit education to instruction, and then to pour instruction into children who are suffering from malnutrition, or defective vision, or defective hearing, or one of a dozen other childish ailments, is at once uneconomical and wasteful, and is a thing of which no sane man would be guilty in dealing with children of his own.

What we need in primary education to begin with is a little cold and brutal realism. Forty-two per cent. of the children who come to our elementary schools for the first time are found to be suffering from some kind of ailment, which will certainly thwart their education, and may permanently injure their health. We need in England nursery schools sufficient to accommodate several hundred thousand children. We actually have 27 schools providing for rather less than 1,000. There are about 164,000 children who are certified to be deficient in this country. We have school accommodation in special schools for 36,000, and of the remainder of those unhappy children, who are in a peculiar sense wards of the community, about 80,000 are attending the ordinary elementary schools, and about 30,000 are attending no school at all. We need in England much better provision for health in the primary schools. Before the War the school bath was much more common in Germany than it is in England to-day. If you look at the report which the secretary of the Association of Education Committees produced a few months ago based on returns from a large number of voluntary schools you will see that it proves that the buildings of some hundreds of schools are not only unsuitable for educational purposes but are probably also injurious to the health of the children. We need many more open-air schools. Apart from the gross deficiencies of certain school buildings there is the fact that the standard of accommodation fixed by the Board of Education is deplorably low. As far as I can find out it is lower in England than in any other country known to me. The minimum floor space required for a child in the primary school according to the Board's Regulations is at present 12 square feet. In the secondary schools which take children of precisely the same age, it is 16 square feet. I have never been able to understand why children in the elementary schools should be supposed to have smaller lungs than their brothers and sisters in secondary schools. In France the floor space is 14.8 square feet ; in Belgium, Denmark, and Sweden it is 16 square feet, and in America it is somewhere between 16 and 20. Those are all very commonplace matters.

I mention them because I want to insist that the care of the physical well-being of children is not merely an addition to or a condition of their education, but that during a certain part of their lives it is their education, and a most important part of their education.

Behind these things lie certain larger questions, the question of the relation of primary education to secondary education, and of both to the educational system as a whole. Here again what we have to do is to turn to the facts of child development. Growth is a continuous process, and therefore education ought to be a continuous process. But growth takes place by stages, and therefore there may reasonably be successive stages of education, which ought to shade into each other without any abrupt break, but each stage of which will possess certain characteristics corresponding to the period of life for which it is designed. Everybody seems to be agreed now that the turning-point in the life of a child takes place with the approach of adolescence. We ought to regrade our education in order to correspond with that fact. Instead of having an elementary system which lasts up to the age of 14, and from which a tiny percentage pass on to some form of higher education, we ought to have primary education for all children up to 11; secondary education, including many different types of school, for all children from 11 to 16, or 18, as the case may be; and higher education consisting of university and kindred institutions above that level.

Given a unification of our educational system on those lines, primary and secondary education, instead of being separate compartments between which rather slender bridges have been thrown, would become successive stages in a continuous process. Both of them would change their character. Primary education would become what it ought to be, namely, preparatory education, and becoming preparatory education it would lose finally the barbarous suggestion of class differentiation which still, I am afraid, clings to elementary education in parts of this country. We should get rid of the separate administrative standards in primary and secondary schools and separate requirements in regard to floor space, amenities and playing fields, and above all we should revolutionize the staffing of our primary schools.

I cannot insist too often that the condition of all serious progress is an immense improvement in the standard of staffing in primary schools. Matthew Arnold said nearly seventy years ago that no class in an elementary school ought to contain more than 40 children. At the present time there are 28,000 classes with

more than 50, and nearly 5,000 classes with more than 60. That is the death of serious education. In my profession, if I may speak as a teacher, we are sometimes reproached, and not unduly reproached, I think, with a tendency to talk, and more talk, and ever more talk, and with a belief that we are broadening our pupils' minds when we are really only elongating our own conversation. That is not wholly our fault. What we want in primary schools is much more practical work, many more occasions on which the child is encouraged not to listen but to act for itself, for both teacher and child far more opportunities for self-organization and responsibility and for the adaptation of educational methods to individual needs. But you cannot do those things—and most teachers are fully aware of the weaknesses of our present system—as long as you staff your schools on the quite inadequate scale on which they are staffed to-day. You turn the teacher into a kind of policeman gesticulating in front of a crowd which is compelled under legal penalties to attend to the performance. We ought to proceed by a series of time-limits to a clearly-defined goal—after 1928 no class to consist of more than 40 children, and after 1932 no class of more than 30.

Primary education in our view—and I think in the view of most educationists—is simply preparatory education, that is to say, the initial stage in a continuous process. To cut it off from the whole, of which it ought to be a part, is economically wasteful, because much of the expenditure in the earlier stages does not mature until the earlier stages are over, and it is also educationally unsound, because it does violence to the facts. But when we ask what provision is made for the children between 14 and 18, we come to what is the darkest point in our educational system. Of the 600,000 children who leave the primary schools rather less than ten per cent. go to a secondary school or junior technical school. A very much smaller percentage, probably not more than one or two per cent., if as much, go to some form of central school. The great majority, more than eighty per cent., are receiving no kind of education whatever between the ages of 14 and 18. The social effects of that neglect have been emphasized until really I am ashamed to speak of them. I remember giving evidence on this subject in 1908 before the Poor Law Commission of that year. Both the Reports said that the present situation was intolerable. In the next year there appeared the Report of the Consultative Committee of the Board of Education on the attendance at continuation schools. That report again said that for the purpose of pecuniary gain we were ruining the characters

of several hundreds of boys and girls every year. Then came the War and a whole succession of reports with which I need not trouble you. I have not the slightest doubt that posterity will regard our callous indifference to the ruin of many of these young persons with the same horror that we look back to the days of child slavery in the cotton mills of Lancashire a century ago.

People very often suggest that only a comparatively small percentage of the children who leave the elementary schools are what they call "worth educating" further. I observe that they do not apply this theory to themselves or to their own children. But, as a matter of fact, those who have gone into the situation and have tried to find out the realities and not simply generalized on *a priori* grounds, tell us exactly the opposite. The recent Committee of Inquiry into Scholarships and Free Places took an immense amount of evidence from teachers, employers and other persons. They said that seventy-five per cent. of the children leaving the elementary schools were "intellectually incapable of profiting by full-time education up to the age of sixteen." We in the Labour movement mean to secure it for them if we can. Let me remove one misapprehension which I am afraid exists. When we put forward that programme and say we want "secondary education for all," we do not, of course, mean anything so foolish as that all children should go through the kind of curriculum which is commonest to-day in what are called secondary schools. Secondary education did not come into existence, as some innocent persons seem to suppose, when the Board of Education first drafted regulations for secondary schools. Whether education is secondary or not is not a question of curriculum; it is a question of the stage of life for which it is designed. A liberal education is not an education which is given through books. How anyone who has ever read many books, and still more anybody who has had to write them, can believe in that illusion, I cannot conceive. A liberal education is an education which brings children into contact with the larger interests of mankind, and a good engineering school or a good agricultural school, or a school which is based on any of the great human crafts and practical interests, is giving a liberal education as much as is a school whose curriculum is more academic.

We want a great development of adolescent education and to include many more types of schools, the foundation of which is practical work. And it is in the development of secondary education that the solution of some of our other problems is to be found. Consider the situation of the English universities that you have in this country to-day. You have in England a university

population of less than 30,000 full-time students of British origin. You have in Scotland a university population of just under 11,000. In England, full-time university students of British origin form 7.8 per 10,000 of the population. In Scotland they form 21.1. If we in England had the same proportion of university students as they in Scotland have, we should have a university population not of 30,000, but of over 70,000. I do not despair of the insignificant part of Scotland which lies south of the Tweed, but I do suggest that that comparison is highly discreditable to us. There is no danger at all that by increasing your university population you will lower the standards. On the contrary, you will raise them, providing you also increase the resources for dealing with students. And, we must remember, that it is to the universities we have to look for the education of the greatly increased staff of teachers that will be needed for the developments of the future. Training colleges have done good work in the past and do good work to-day. Nobody wants to see them abolished, and if they did it would not be a feasible proposition because some 8,000 new teachers are wanted every year. We cannot receive them all in universities, but a greater proportion of teachers ought to be educated in universities and take a postgraduate course of training. Again I appeal to the example of Scotland.

There is also the economics of the situation to be considered. Economic success, in the long run, depends on two factors—natural resources and human intelligence. The age when Nature was pouring wealth into our lap has vanished. We have now found our own level, and on the whole it is a good thing for us that we have done so. That has come about through the adoption by the world at large of modern industrial technique. We have not got now anything like the adventitious advantages we had in the past, and one of the things that economic wisdom should teach is to use the resources of a coal age, which will one day begin to come to an end, to build up in the meantime the great social services which are needed to develop intelligence.

Let me say one word about the application of scientific organization to one particular sphere of education. Progress in education, as in any other great co-operative undertaking, depends on what one may call staff work. By "staff work" I mean the collection and systematization of knowledge, and the use of that knowledge to think out a clearly conceived and continuous and consistent policy and, at the same time, to provide the nation with the information which is needed in order that the public, upon whom policy ultimately depends, may be in

a position to judge of it. Unless that work is constantly going on, administration degenerates into routine, the service lives from hand to mouth, the central department ceases to be regarded as a centre of enlightenment, and the public is not prepared to co-operate with it because it has not got the data upon which alone intelligent co-operation can be founded. I must say I think that in those respects English educational administration, with all its great virtues, has been extraordinarily defective. The Board of Education receives, in the course of its administrative duties, material of quite unrivalled interest and importance, but, unfortunately, it is read only by officials, and then it is buried until the day of judgment when some German *savant* will investigate the past educational system of the British Empire. What we want in education is co-operative thinking. We have got brains. What we want is a brain.

I suggest that a Minister of Education who is precluded by political circumstances from indulging in far-reaching legislation might do worse than set himself to consider how to make the Board of Education an effective thinking department. One of the highest officials ought, in my opinion, to specialize in that particular function of organizing intelligence. It is a maxim of war, and it ought to be a maxim of administration, that staff work must be separated from operations in the field. We ought to take the special inquiries branch and make it the nucleus of a real intelligence department, making comparative studies of educational methods and policy at home and abroad and thinking out continually what are likely to be the problems, not of this year or next year, but of some years hence. The Board of Education ought to be provided with a small free revenue which it can apply to encouraging research. There is a certain amount of research being done by the department, as well as in places like the psychological laboratories of universities. It is extremely important that the State should encourage it. At the same time, we ought to see that the public is regularly supplied with a constant stream of reports giving full information about educational problems, both in this and other countries. Unless it is provided with such information, the public is not in a position to make up its mind.

I have been engaged in different forms of agitation for a good many years now. The conclusion I have come to is that you cannot persuade the public to believe the kind of nonsense about economic questions which it used to believe years ago, because there are now many authoritative reports supplying information to which they never had an opportunity in the past of getting

access. But my experience is equally that the public will believe anything that is said about education—even a report like that of Sir Eric Geddes. The reason is simply because the Board of Education is not giving us the material by which we can expose inaccuracies, however gross. So I plead, as the foundation of reform, that we should give our attention to organizing intelligence in the educational service. That work is of incomparable importance. I observe that those of my fellow-countrymen who do not appear to be doing anything in particular in the present, are fond of saying that they are working for the future. That maxim is an unimpeachable one, but let us apply it. The future is not half a century hence ; the future is with us here and now. It is attending His Majesty's elementary schools.

HUMANISM IN SCIENCE

Sir THOMAS H. HOLLAND, K.C.I.E., D.Sc., F.R.S. : One aspect of this Conference is at variance with my feelings, and that is the tendency to suggest that a scientific man belongs to a caste apart from his fellows.

We have developed a habit of calling a man scientific when the materials he handles are microscopic sections, fossils, stars, electrons, fossils or germs ; the less marketable his products the more scientific the worker is in the popular estimation. As a consequence of general unfamiliarity with the materials with which the so-called scientist deals, he has been alternately looked upon as a harmless lunatic or treated as an ascetic because of his desire to know things that are of no apparent practical value. He has probably not deserved as a class the full share either of ridicule or of reverence which he has received. It is difficult for us nowadays to appreciate the state of public feeling in the days when Swift's satires at the expense of the Royal Society, in Gulliver's introduction to the academy of Lagado, could be regarded by educated people as tolerable literature ; or still earlier, when the celebrated Dr. South could with impunity describe the members of the Royal Society as incapable of admiring anything " except fleas, lice and themselves."

Yet there is a remnant of this idea still in existence : the boy who goes out of the public school seldom sees any connexion between the science he is taught and the profession to which he is subsequently apprenticed, because the science master has, as a rule, no practical acquaintance with the industrial aspects of the sciences which he teaches, being generally more in touch with

the professors of the so-called sister sciences than with the human aspects of his subject.

Science has been defined as " nothing but trained and organized commonsense " : the prominent difference between ordinary and so-called scientific knowledge being the sporadic character of the one, and the systematic character of the other—the systematic observation of facts, their grouping into classes of like kind, the drawing of deductions from established propositions and their verification by experiment or observation. These are the methods of science ; but they are by no means the monopoly of the man who deals with biological, mathematical and astronomical problems. The scientific method is just as necessary, and is just as often employed, in industrial affairs as in matters of no immediate economic importance.

In selecting a phase of our subject for discussion, I propose to deal with a question which has not so far been discussed here, namely, the responsibility for education which is now being transferred from the shoulders of the classical to the science master. Our science teachers have shouted for long about the uselessness of the old-fashioned classical education, and as the result of their agitation, aided by the War, they have come into their own with embarrassing suddenness.

Now the scientific man can never remain merely an expert in the classroom and laboratory. He has duties as a citizen ; he must face relations, and competitive relations too, with other human beings, with most of whom he is unable to communicate in technical terms alone—the technical terms that he learns in the classroom. To be appreciated, he must understand and be understood by others ; he wants the " humanities " in some form.

The study of classical literature once meant in reality the study of the humanities. Late in the Middle Ages, the study of the classics revealed to the world the long-buried wisdom especially of the Greeks—their art, their philosophy, and, more important, their science. That discovery gave rise to the great movement which we speak of generally as the Renaissance—the revolt of intellect from previous feudalism and theological bondage, resulting not only in the revival of literature, art, and that religious freedom which is generally known as the Reformation, but in the development also of scientific curiosity, what, to avoid the secondary meaning of curiosity, we now call research. The Renaissance gave us in practical form the mariner's compass and, with the exploratory spirit which accompanied it, the discovery of the

Americas, of South Africa, India and the Far East ; it gave us the invention of gunpowder and that of paper and printing, which facilitated the distribution of the new learning to a wide world.

The lesson to be learnt from the Renaissance is strengthened by a consideration of what happened afterwards to classical studies. With the passage of time classical learning, like an organism, went through a period of vigorous youth, vitalizing the world with new energy and new ideas, till it reached the stage of adolescence, and, with it, specialization.

That is the life-history of every organism. With specialization, the humanistic study of the classics became swamped by its linguistic, grammatical and purely rhetorical aspects ; its main object became obscured and stricken with a formalism that " has given us false ideas, and the narrow spirit of a mutually admiring coterie, that wrote Latin and Greek verses to one another and to no one else. It has engendered a wild form of pedantry that regarded a false concord or a false quantity in Greek, not at all as we should regard a similar mistake in French, but as a shock to the higher order of things, which deserved scorn and reprobation when committed by a man, cruel punishment when committed by a boy."

These are not the words of a prejudiced and jealous scientific man, but the judgment of a distinguished classical scholar, the late Vice-Chancellor of Oxford. Reviewing the situation in this way before the Congress of Universities which met at Oxford in 1921, Dr. Farnell pleaded for the revival of humanism in classical studies, and I wish similarly to draw your attention to the importance of humanism in science and technology ; for we also are exposed to the very same danger that has now nearly strangled scholarship in our public schools and younger universities.

I want to bring home to you the danger of defeating the very end of science itself ; for scientific men are also liable to be warped by that form of pedantry which, in classics, exchanged humanism for grammar and rhetoric and that homologue of pedantry in religion which tends to mask doctrine by ritual. Do not let us claim that science can give a mental training as *good*, when in reality we mean as *bad*, as that afforded by classics.

Let us take as an illustration an extract from a syllabus of metallurgy, as given in the prospectus of a well-known technical school. The syllabus includes the following entry : " Bessemer and open-hearth plant and processes."

A fair summary of what I, as a junior student, had to learn under this head would be as follows :—

" The original Bessemer process, as conducted in a ganister (silicious) lined converter, does not effect the elimination of phosphorus from the pig-iron ; but, by using a basic (dolomitic) converter, Thomas and Gilchrist found it possible to eliminate the deleterious element that affects the quality of the resultant steel, and so it is now possible to use a phosphoric pig-iron for steel-making."

That is an extract from my notebook as a boy. There were a good many other dull details, but they all left me " cold."

Later on, coming under the influence of a professor with a wider outlook of the world, I learnt that this so-called basic process changed the whole of our international relationships. It opened up the enormous phosphoric ore-deposits of Germany, Belgium, and America. It resulted, therefore, in a challenge to British supremacy in the steel business. Just think of what that meant to railway development, shipbuilding, machinery and dozens of dependent industries ! Obviously realization of this, to me, quite unforeseen meaning in a purely technical fact opened up a new world of human interest ; and most of all, made one inquisitive. One's curiosity was aroused and one took the earliest opportunity of finding out more about this wonderful basic process, and about the two men who invented it. The human soon superseded the technical aspect of the question.

I am ready to assert that a review on these lines of the way in which the basic process of steel-smelting has affected history, especially when so touched with the human relations of the two men to whom it is due, is all that is necessary for the student. He will soon satisfy his own curiosity about technical details ; he will soon be studying the question himself in the library and the workshop.

This stirring of that form of curiosity that Dr. Johnson called " the thirst of the soul " and " the characteristics of a vigorous intellect," will give human living interest to a student's work. The teacher's task is three parts done and faithfully fulfilled when he has inspired the student sufficiently to impel him to find out the rest for himself. And what a student finds out for himself is far more valuable to him in after life than anything he is taught.

In a thoughtful paper read before the Congress of Empire Universities at Oxford in 1921, Dr. Cecil Desch advocated the adoption of the historical method in science teaching. But history consists of innumerable biographies ; as Emerson said, " there is properly no history, only biography." History, divorced from biography, can be as dull and deadening as either Greek grammar

or descriptive technology. The educational balance is not secured by requiring students to attend a formal course of classics or history as well as of science. That would be merely to double the offence. A doctor does not apply a counter-irritant if he can get at the seat of the disease. It is not separate courses of history and science —a mechanical mixture—that are wanted, but the history of science itself, that is, a chemical compound. Giving two separate doses of two unrelated subjects to act as mutual correctives is equivalent to giving a man a metallic sodium pill with a sniff of chlorine gas when what he wants is merely a pinch of common salt. The two constituents given separately might be fatal, whilst the two in the form of the compound sodium-chloride make an essential food.

I would consign to the same category such intellectual bye-products as a critical commentary on Latin texts, a jumble of metallurgical terms, and, say, the terminological babblings of a golfer in plus-fours after he has done a course of 18 holes in 70.

Let us revert for a moment to the paper by Dr. Farnell which I have quoted already. He states, with authority, that "the decline of classical studies increases alarmingly. Even in the older public schools, where classic culture was the sole tradition of the past, the desertion of Greek has been extraordinarily swift."

Where he refers to the change as "alarming" he does not mean to the classical professor merely; it is even more alarming to those of us who are responsible for replacing the classics by science and technology in that portion of the student's training that follows the matriculation stage. When we remember that our principal public men and the great army of administrators who have made the British Empire what it is, have been brought up mainly on a diet of classics, we ought to realize the great responsibility that is now being transferred to the shoulders of teachers of applied science.

If we conduct our educational classes exclusively to improve the technical efficiency of our students, the good that we do will be more than counterbalanced by widespread harm. We come here in the hope that we will return to our institutions better able to train young scientists and technologists, it is but natural that you should have uppermost in your minds their technical efficiency. Let me remind you of the new responsibility that now falls on us as usurpers of the educational authority which was formerly wielded mainly by our teachers of classics. Let us try to find out why they were successful, for they certainly were so, even conspicuously so. If you could see, as I have, how young members

of the Indian Civil Service handle the administration of their districts—with sympathy as well as justice and efficiency, not here and there, but nearly everywhere, not under the eye of the Press or Parliament, but alone and unobserved—you would seriously begin to search for the cause ; for nine-tenths of the data employed in their education have no direct bearing on the problems with which they are faced.

If it be true that our young men are deserting classics for science, it is our duty to see that, with the change of the subject, the spirit of education is still preserved.

Now beyond question, an important part of the education of every administrator of human affairs should secure a preservation of the spiritual sense of history. To take an exaggerated illustration, there would be no difficulty in deciding whether the harm outbalanced the good if an engineer pulled down a cherished and apparently useless monument to build a modern and useful bridge. No paper would be allowed to print what every engineer in the world would say if we, at South Kensington, constructed a new engine out of parts of Stephenson's " Rocket." As a mere locomotive it is beneath contempt, but as the first to exemplify the three essential features of the modern locomotive it is, as an inspiration for the railway engineer, worth its weight in any metal.

We were often told before and during the War that German industrial progress was due to technical education ; but those who told us so seldom realized the value which the Germans placed on technical history. In 1885, for example, they sent over a party of engineers to construct a perfect copy of the " Rocket," which was true even to the marks accidentally made on the boiler plates by the crank, and their " copy " is exhibited in a suitable building at Munich, whilst our " original " is still in a wooden shed at South Kensington in the capital of the Empire.

If the older system of classical education justified itself, not by the out-turn of experts in the Greek and Latin languages, but by the development of character and capacity for affairs, we have to see to it that science and technology are also so taught that these essential features are developed, not inhibited, in the student.

A NATIONAL SYSTEM OF EDUCATION

Dr. R. P. SCOTT, M.A., LL.D. : My remarks will be confined to one of the topics of discussion suggested by the Committee, of which the third runs as follows :—

In our national system of education means should be devised

(*a*) For ensuring continuity in public educational policy ;

(*b*) For making readily intelligible to the public the organization of education, and for circulating in each area full information concerning the institutions there available; also

(*c*) For stimulating public interest in education, and encouraging enlightened personal service in its local administration.

A discussion of these features of a national system provides for their advocate a task at once singularly easy and remarkably difficult. Easy, because it states what everyone who is free to express an opinion will regard as obvious. Thus, among those who realize the bearing of education upon happiness and national welfare, who will not desire continuity—that is, persistency of purpose—in the policy of our Board of Education? For only from such a policy, sustained and rightly directed, can we hope to develop an educational system at once characteristic of our distinctive culture, and truly adjusted to our national needs. Again, who would not welcome a full supply of local and other information concerning schools and institutions (fees, scholarships, aim of the instruction, its range, and so on) such as would make clear and understandable concerning each institution, both what it stands for and its place in an orderly system—as clear, for instance, as in France or Germany? Who would not desire that public interest in education should be aroused and become informed and keen—as informed and as keen, for instance, as in Wales or Scotland? Or, finally, who would not wish that fit and proper persons should be encouraged to devote time and thought to helping schools and institutions to do their own peculiar work, that is, to develop intellect and to train character?

All this is obvious; but the obvious may be defined as that which is too near to the spectator to be perceived by him. That is the difficulty which surrounds each one of these desirable features. All are accepted as obvious, but none is provided. In our system—such as it is—no considered place is found for them. These features—a continuous policy, an intelligible system, public interest in education, though desired by all, appear but sporadically and then as accidents. Our State system of administration, controlled by central and local authorities, is not a system at all. It is mere practice, based not on thought, but on routine. Mr. Squeers' method is inherent in it. It will be remembered how he dealt with Smike: "Spell 'window.' What! you can't? Then go and clean it." Instead of being a system, it becomes a cyclopedia, bundles of regulations, a maze of decisions, a nightmare of forms. What Science asks for education, and what Labour will insist on, is that we shall no longer be content to

muddle through with it ; but that in some defined way, ordered thought shall be brought in before action ; so that method and consistency may have a place in " this mighty maze without a plan."

This demand is not new. It was made in the most authoritative manner nearly seven years ago in a document of supreme importance. In 1917, Lord Haldane presided over a committee of seven appointed to consider the Machinery of Government—a committee ideal both as to numbers and personnel. All the members were responsible and practical persons. With Lord Haldane were associated Mr. E. S. Montagu, about to be appointed Secretary of State for India ; Sir Robert Morant, then Permanent Secretary of the Board of Education, a master of principles and details alike, possessed of insight and wide experience ; Sir George Murray, the able and indefatigable head of the Treasury ; Sir Alan Sykes, a Lancashire business magnate ; Mr. Thomas, the present Colonial Secretary ; and Mrs. Sydney Webb, whose work testifies to her thorough knowledge of administration and of industrial conditions. The Committee sat for eighteen months and issued a practically unanimous report. As it happens, a recent letter in *The Times* (25th May) commended the findings of this Committee to the attention of the Prime Minister. In doing this, Lord Esher, though chiefly concerned with the recommendations dealing with the overlapping of central authorities—as, for instance, when the Ministries of Education and of Health are both consulted by the same local authority when providing a single school—pointed out that the recommendations apply equally to the work of individual Ministries—Health, Labour, Education, and the like.

The section headed " Formulation of Policy " in this report begins as follows :—

> " We have come to the conclusion after surveying what came before us that, in the sphere of civil government, the duty of investigation and thought, as preliminary to action, might with great advantage be more definitely recognized. It appears to us that adequate provision has not been made in the past for the organized acquisition of facts and information, and for the systematic application of thought as preliminary to the settlement of policy and its subsequent administration."

It is evident that each of the great departments of State performs in its own sphere two separate functions or duties. The one is to determine for the department the best methods of organization and to make the best preparation for action ; the other is the actual transaction of its own special business.

These functions are distinct—a fact less easily realized in civil, than in military or naval, matters. In the War Office, for example, when policy in any direction has been settled by the Cabinet—say, the Gallipoli Expedition—the thinking out of the plan is undertaken by a General Staff and the resulting administrative work by another set of officials, before instructions for action are issued to commanding officers in the field.

In presiding over this Committee, Lord Haldane was in an enviable position. He could commend to his colleagues the particular machinery which he had already put into successful operation at the War Office, concerning which it may be said that in winning the War, England owes much more to the method of organization there set up than is generally understood. The Committee recommended that the machinery which had been so efficacious in the War was equally applicable to civil affairs. For this the time is ripe. In 1652, at the close of our Civil War, Milton in a famous sonnet appealed to "Cromwell, our chief of men," to complete his work and to pass from military to civil victory. England had been saved, he declared, from tyranny in government; she needed saving now from imminent tyranny over the mind. In words as relevant to-day as they were then, the poet affirmed that "Peace hath her victories no less renowned than War." What is implied in this truth we have first to realize and then to act upon. Peace has her difficulties, her sacrifices, her losses, just as War has; it is for us to overcome the difficulties, to make the sacrifices bear fruit, to see that the losses are reduced to a minimum. In education we do this not for ourselves but for that army of little feet which thirty, or forty, or fifty, years hence will be marching in our places in the endless crusade against ignorance and sloth, from which perforce we have dropped out. These words are not mere rhetoric, but sober fact; they challenge not votes, but thought—a very different matter.

Turning from general considerations to particular cases, we may take two or three flagrant examples, which show that central educational policy has not been consistent; and that local policy may be so conceived as to produce a deterrent effect upon willing and public-spirited persons.

It is contended that most of the evil results which have inevitably followed vacillation, or wobbling, in educational policy might have been avoided. The question is whether vacillation is inevitable, or whether some course of preventive medicine cannot be applied to the Department of Education? As to the need of such a treatment let the following examples testify.

Take first the central authority. Not merely occasionally, but as an ordinary matter of practice year by year, the Board of Education, having no fixed standard of qualification for intending teachers, deliberately raises or lowers the examination standard for entry into training colleges, a test which roughly corresponds to matriculation. This is a practice that the Board has steadily and rightly discountenanced in university examining bodies. These require, for instance, the student to pass matriculation before proceeding to a degree. In this matter, however, the Board acts rather as an employer having posts to fill than as a trustee for national educational interests. The right course would be to give certificates of proficiency to all who reach the required standard, and then to admit to the colleges as many as there is room for, whether this number exceeded or fell below the number certificated. Arrangements for subsequent certification of those, if any, admitted without certificates, ought not to be difficult. To continue the present practice is to disqualify at the very outset the claim of teachers to a professional status such as that enjoyed by doctors and lawyers. Those who desire teaching to acquire this status should insist that uniformity of standard in the examination which guards the threshold is essential to the end they have in view, for no self-respecting profession in England or elsewhere ought to tolerate a varying standard at that critical point.

Again, the fact that at present there are many more trained teachers than posts is largely due to the ineffective resistance, weak because merely personal, made by Mr. Fisher, when Minister of Education, to the shape which the Geddes recommendations assumed. Now that a more liberal policy of staffing is being adopted, the supply of trained teachers may be expected soon to fall short of the demand. There is no need to dwell on the loss of time, of money and of hope involved in these vacillations. Moreover, discontinuity of this kind harms the efficiency of the service. When policy changes and more trained teachers than are available are needed, less qualified substitutes are appointed to the vacancies. Trained teachers cannot be improvised or obtained on the spur of the moment. To keep up the supply, planning a long way ahead is necessary.

Take another case: the way in which pensions to teachers and increased salaries have been handled. In 1918, the Board of Education came to the very just conclusion that teachers were grossly underpaid. The pressure of war convinced the Government also, and Parliament was asked to redress, as best it could, the nation's sad loss of promising young lives. It was a sound

instinct that turned for this purpose to schools and teachers. The Board thereupon set going for teachers two reforms at once —both good, both necessary—pensions and increased salaries. But, with amazing lack of forethought, it omitted to consider the relation of the two, even though pension is based on salary. Fancy a merchant doing business in such a manner ! Or a scientist conducting dependent experiments on such lines ! A new policy is now being adopted, or perhaps it would be truer to say the kaleidoscope has taken another turn. The cost of pensions to the State is declared to be excessive ; and the State now wishes to pass over to local authorities and to teachers a part of the burden which it had assumed without consulting them. Is it to be wondered at that both authorities and teachers are irritated ? It is undesirable to make too much of this lack of foresight in a good cause, but approval of increased emoluments to teachers should not hide from consideration the lack of method which has produced such large and needless friction.

Turning to local administration, we may consider a single minor example. A liberally-minded county education authority recently has had practically to supersede the governing bodies of its own schools in the appointment of Head—the most important function a governing body is ever called upon to perform. It is true that the action of the authority was amply justified, owing to the narrow and one-sided view which these governors took on any appointment placed absolutely in their hands ; but good governing bodies cannot be created wholesale or at will ; they have to be trained, as much as teachers have ; and able men will more and more shrink from accepting membership of bodies whose powers are reduced to a nullity. New bodies like these, composed of persons who in general do not serve on other public bodies, might be made to serve as practising schools in administrative service. Real responsibility, even though on a small scale, would bring home to their members—for Englishmen learn better in action than in any other way—the actual difficulties of administration. Governors of schools and of local colleges, though interested in their task, are as a rule not really cognisant of the problems of education on its administrative side. They desire, however, to render disinterested personal service to the institutions, and therefore deserve encouragement. They should neither be suppressed nor depressed, but should be nursed into efficiency by the authority which appoints them—a task not difficult, if only it realized the conditions of full educational efficiency. Here once again, routine—the cult of the bureau—should yield to the

patient thought necessary for building up an organic system. True organization is not mere systematization, pigeon-holing on a wide scale, but the continuous adaptation of a living organism to its proper uses.

The remedy for much of this uneconomical dealing with organization, and for most of the shortcomings of the Board of Education, is not far to seek. It will be found in two stages: first, in a recognition that the time has come for central authorities to readjust themselves to the changes which have come over our social, economic and political worlds in England. It will be no more difficult—though perhaps no less—for the Board of Education than it was for the War Office to adjust itself to new conditions; and a similar road has to be taken. Then, as the War Office relies on its General Staff for evolving policy, so must the Board set up a general staff or education council, out of its own exceptionally able officers who now lose their effectiveness by acting rather as individuals than as a team. Certain heads of the office—including in this term those on the educational as well as those on the administrative side—should be brought together under proper conditions to think out the Board's problems. Such a body could be trusted to develop a corporate mind; this would presently bring continuity into policy and more of the human factor into administration. It would be the function of such an advisory body to review all the activities of the Board, and to report from time to time to the Minister, through the Secretary, as to the manner in which the exercise and distribution by the Board of its functions should be improved. In order to do this satisfactorily, this body should have assigned to it exact terms of reference, and a definite constitution including officers, i.e., a chairman and a secretary; and should meet regularly and keep minutes. One of its functions would be to inform itself of the actual working of educational systems and administration in foreign countries, and, in particular, of that of our own. Also, it would be empowered to commandeer such statistics and expert advice as might be necessary. By this means the hands of the Minister would be strengthened both in planning reforms and in carrying them through; and corporate thought would secure for him a wider acceptance and a greater stability of policy than any of his predecessors has enjoyed. More than this, administrative action could then be based on wide as well as accurate knowledge, while proper publicity could be ensured for such memoranda and other detailed work of the Board as it might be desirable to publish. Much of this, although of very high value, is now merely pigeon-

holed, in absence of a thinking organ to estimate the Board's efforts, and to correlate its various activities. In this way, too, scientific method could be brought into this all-important department of State; and Labour could then rest satisfied, as now it cannot, that the utmost value is being obtained for the nation's greatest, but as yet most imperfectly realized, asset—the intellect and the character of its children.

An old *Punch* cartoon may perhaps serve to drive home these points and to sum up the present situation. Arriving in an unfamiliar town, a newcomer was greatly puzzled at seeing two tall and fine-looking men, each with immobile countenance and a preoccupied air walking at a deliberate pace along a main thoroughfare, holding aloft the left arm crooked at an uncomfortable angle and keeping a constant distance apart. Addressing the second actor in this scene the newcomer said, "Pray excuse my curiosity, but what are you and that gentleman in front supposed to be doing? Are you practising a new form of gymnastics, or working out data for some curve of fatigue, or only, perhaps, fulfilling the terms of a wager?" The man addressed stopped dead, lost his unconcern, and, suddenly taking in the situation, shouted to his mate in front, "Bli' me, Bill, we've forgotten the ladder."

This episode not inaptly illustrates the atrophy of imagination which occurs in the mind of busy persons engaged in any occupation from bricklaying to education, when their daily work is divorced from organic thought. Such divorce does more than diminish output of work: it reduces the potential craftsman to a mere piece of machinery.

DISCUSSION

Mr. T. LL. HUMBERSTONE, B.Sc.: We have in Mr. Tawney a man who stands high in the educational counsels of the Labour Party. Well-known as the advocate of an extended system of secondary education, he invented the slogan "Secondary Education for All." I would venture to suggest, with great respect, that the exponents of that policy are prone to overlook its financial aspects. Secondary education in London to-day costs nearly £40 per child. One can see that if a parent had five children, all of whom received secondary education, the cost would amount to £200 a year, and that this would be enough to earn a living for the parent, if he were able to teach his own children. We have heard of people who live by taking in each others' washing, and I suppose it would be equally practicable for people to earn their living by teaching each others' children. That would be the

Millennium for which we have waited so patiently. A certain proportion of boys would obtain more benefit after reaching the age of fourteen from active work than from full-time education. I am not arguing the question on "class" lines. I was at one time a public school science master, and am able to speak from experience, and I say with conviction that a number of boys in public and other schools over the age of fourteen would be better employed, at least for part of their time, in some form of active work, if it were only digging potatoes, than in full-time education. There is a regrettable tendency to overlook the educational value of work. One of Conrad's characters said: "I don't like work—no man does—but I like what is in work—the chance to find oneself, your own reality—for yourself, not for others—what no other man ever knew." The best method of developing the personality of each individual boy or girl is the fundamental problem. Some children of weaker personality receiving full-time education over the age of fourteen would tend to be overborne by their teachers, and to become weak imitations of their teachers. Their vitality would be impaired and you would create a number of school products whom you would have no difficulty in recognizing in after-life. Mr. Tawney, as a university lecturer, knows that young university students are not expected to take their teachers too seriously. England must not produce a race of "schoolmarms."

With one other part of Mr. Tawney's thesis I find myself entirely in agreement, and that is the need for promoting research in education. A great deal remains to be done in the way of educational research, and I look forward to the time when we shall utilize more effectively some of the discoveries of science, such as the cinema, the gramophone and broadcasting, as a means of education, and so extend our conception of education beyond the ambit of the classroom.

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